DEC. 20¢

POPULAR SCIENCE

HOW THE BOMBSIGHT SOLVES PROBLEMS PG. 116

(Continued on facing page)

RAINBOW IN THE SKY

There is good news in the work of American laboratories. It is a reason for confidence in the war — a promise for the future.

Little is said about our scientists because they labor behind locked doors and their work is secret. But the topside of the German and Japanese armies and navies know about them. Things they do turn up at the front and make life harder for our enemies.

After the war, from these same scientists and their laboratories, will come the things that make jobs, comforts, conveniences and luxuries for the American people. They hold out prospects for good use of the opportunities victory will bring.

The Bell Telephone Laboratories, with some seven thousand workers, are among the many research groups that are devoted to winning the war.

When that is done, Bell System scientists will be back on their old job of making your telephone service, and your human contacts over the distances, easier and better than ever.

BELL TELEPHONE SYSTEM

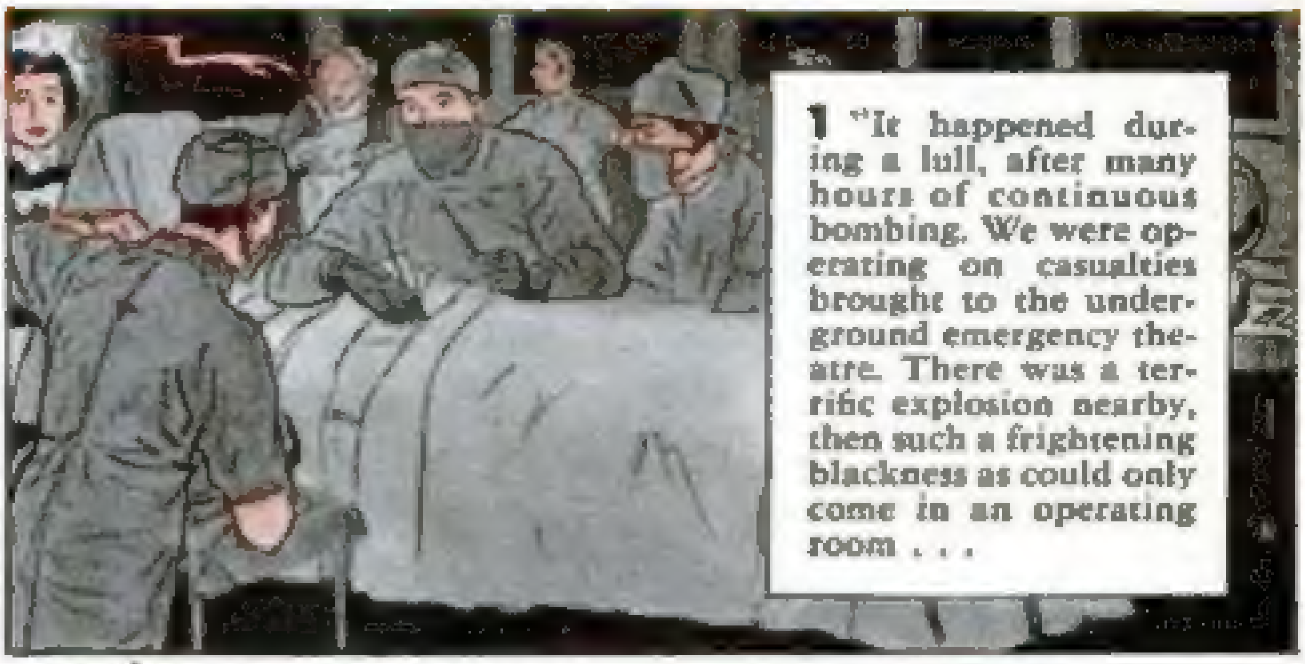
HELP THE WAR BY MAKING ONLY VITAL CALLS TO WAR-BUSY CENTERS. THAT'S MORE AND MORE ESSENTIAL EVERY DAY.

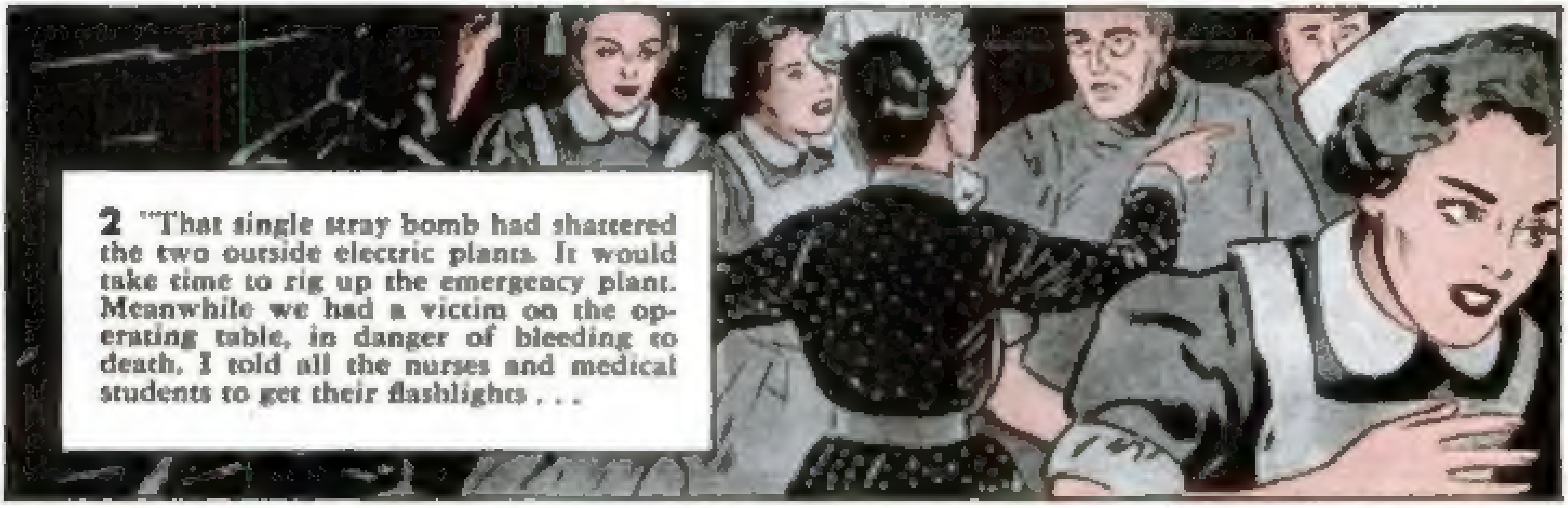
Popular Science Monthly for December, 1943. Volume 143, Number 6. Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Yearly subscriptions to the United States, $2.00.

BLACKOUT IN THE OPERATING ROOM!

A true story of the war, as told by SISTER ISABEL NIXON, *Head Nurse of St. Thomas Hospital, London,* to a war correspondent.

The centuries-old London hospital has three distinctions. It is London's most bombed hospital (undoubtedly because of its proximity to the Houses of Parliament just across the Thames). It has not during this war lost an air raid victim. And it was the home of Florence Nightingale. Headnurses still wear the same uniform and lace-edged frilled bonnets pioneer Nightingale wore during the Crimean campaign.





It's not your dealer's fault if he happens to be out of "Eveready" flashlight batteries. Most of those we can make are going to the armed forces; nearly all the remainder are taken on priority by the war industries.

A free copy of "You and the War," the official guide-book to all home defense activities, will be sent to you on request. Civilian Defense needs your help; this book will tell you how to give it. Address: National Carbon Company, Dept. FR, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY, INC.
30 East 42nd St., New York 17, N. Y.
Unit of Union Carbide and Carbon Corporation

UCC

The word "Eveready" is a registered trade-mark of National Carbon Company, Inc.

FRESH BATTERIES LAST LONGER . . .
Look for the DATE-LINE

Buy War Savings Bonds and Stamps regularly.

Coming Next Month

A NEW COAL AGE is coming—to supplement our dwindling supply of oil. Today our list of coal products—ranging from plastics to perfumes—is a long one. But it will look short when research chemists get around to applying what the war has taught them about the amazing new uses of coal. Don't miss this interesting preview by Albert Q. Maisel.

FIREPOWER in fighter planes is now probably the dominant factor in aerial supremacy. In an article replete with charts showing in detail the armament of the deadliest fighters now flying the skies, Arthur Grahame tells you everything you want to know about today's best aerial weapons, and explains why the U. S. is leading the race to equip planes with guns that spit out the heaviest bullets at the highest velocity.

NAVY SALVAGERS have had a busy but profitable time of it since Pearl Harbor. In return for $5,000,000 spent in operations, they have recovered hulls and cargoes valued at $400,000,000. Here is a thrilling story of the amazing ingenuity with which our salvage experts are reclaiming ships that have been sunk, stranded, or cut in half.

"LITTLE HUSKY" IS THE NAME for a model steam engine which can be built wholly without castings. Though the model engineer can't buy rough castings for his engines now, this step-by-step article shows how scrap metal can be used instead.

AMPLIFIERS ARE VITAL to almost all electronic devices. In the next installment of the "First Steps in Electronics" series, John W. Campbell, Jr., tells you what these almost miraculously sensitive circuits are and how they work.

INTERNATIONAL CORRESPONDENCE SCHOOLS

BOX 7666-K, SCRANTON 9, PENNA.

Explain fully about your course marked X:

TECHNICAL AND INDUSTRIAL COURSES

- Air Brake
- Air Conditioning
- Airplane Drafting
- Architecture
- Boilermaking
- Auto Technician
- Aviation
- Blueprint Reading
- Bridge Engineering
- Chemistry
- Coal Mining
- Civil Engineering
- Diesel Engines
- Drafting
- Electrical Drafting
- Electrical Engineering
- Electr'n
- House Planning
- Foundryman
- Heating
- Heat Treatment of Metals
- Highway Engineering
- Industrial Metallurgy
- Locomotive Engineer
- Machinist
- Inspector
- Marine Engines
- Mechanical Engineering
- Navigation
- Plastics
- Patternm'k'g
- Plumbing
- Public Works Engineering
- Radio Operating
- Radio Servicing
- R. R. Engineering
- R. R. Section Foreman
- R. R. Signalman
- Refrigeration
- Sheet Metal Work
- Ship Draft'g
- Shipfitting
- Shop Practice
- Steam Elect.
- Steam Eng.
- Structural Engineering
- Surveying and Mapping
- Telegraphy
- Telephony
- Toolmak'g
- Tool Design
- Welding, Electric & Gas

BUSINESS COURSES

- Advertising
- Bookkeeping
- Business Management
- Cartooning
- Civil Service
- C. P. Accounting
- College Preparatory
- Commercial
- Cost Accounting
- Foremanship
- High School
- Illustrating
- Show Card, Sign Lettering
- Railway Postal Clerk
- Salesmanship
- Secretarial
- Spanish
- Traffic Management

HOME ECONOMICS COURSES

- Advanced Dressmaking
- Foods and Cookery
- Home Dressmaking
- Professional Dressmaking and Designing
- Tea Room Management

Name...*Age*..........

Address...

City...*State*....................

Present Position..

Canadian residents send coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada. British residents send coupon to I. C. S., 71 Kingsway, London, W. C. 2, England.

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 143 NO. 6

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS *for* DECEMBER, 1943

Cover: Painting by Jo Kotula

News

Automobiles

Home and Workshop

C. B. COLBY, our new aviation editor, made his first flight when 15, sitting on the lower wing of a Curtiss seaplane with his arms around the motor struts. He has been writing and illustrating aviation articles almost ever since. For the past six years he has edited top-flight aviation magazines. He is a power as well as a glider pilot, an officer in the Civil Air Patrol, and one of the original members of the Aviation Writers' Association.

Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Charles McLendon, Stephen F. Glennon, Vice-Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

Yearly subscriptions to United States and its possessions, $2.00; Canada, $2.50; foreign countries, excepting Canada, $3.00. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

HELLO BOYS!

the world's greatest toy factory is fully enlisted for war production...but toys from unrationed materials are still coming from the GILBERT HALL of SCIENCE

A. C. Gilbert

PRESIDENT
The A. C. Gilbert Company

WHEN the box says "developed at the Gilbert Hall of Science," you know it's on the beam . . . crammed with fun and action! American Flyer Trains—those spectacular "Hot Shots" that reproduce the thrilling "choo-choo" sound effects of a real train . . . the famous all-electric, super-mechanized Erector . . . Gilbert Chemistry sets . . and other Gilbert scientific wonders.

Because Uncle Sam needs metal for war, American Flyer Trains and Erector sets cannot be made this year. But perhaps you can think of some older boy in your neighborhood who had a set he has outgrown . . . and Dad can get that set for you this Christmas. Start your search *right now!* Also, visit your local toy store and ask to see other Gilbert Products.

When in New York, visit the Gilbert Hall of Science—5th Ave. at 25th St

The Army-Navy "E" Flag, won by Gilbert workers for high achievement in war production.

ERECTOR JUNIOR builds big action models

NEW ERECTOR JUNIOR

"Just pin-peg parts together"

It's a snap to build thrilling action models with Erector Junior . . . bridges, cranes, airplane ride, dozens of others. Fascinating array of punched strips, wheels, axles and other exciting parts. Made of wood—like famous mosquito bomber. Parts fasten together with big, easy-to-grip pin-pegs. You don't need a screw-driver.

GILBERT CHEMISTRY SETS

It's fun to master CHEMICAL MYSTERIES

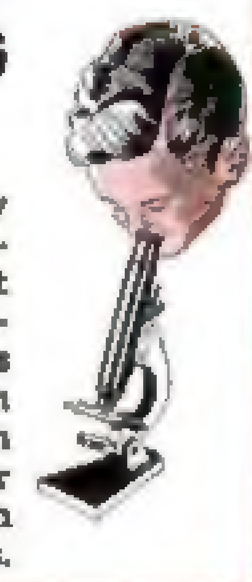
the kind that bring boys fame.

Here are Burton Feinerman and Hans Mark, who won $100 for chemical research this year. More boys have won fame and big awards with Gilbert Chemistry Sets than any other kind. They are more than "toy sets." Write messages in fire ink. Make chemical weather flag. Hundreds of other spectacular experiments. Write for details on $200.00 in cash awards offered to boys doing most important research in chemistry in 1944. Address Gilbert Hall of Science, Erector Square, New Haven, Connecticut.

NO. 6 DOUBLE FEATURE, DOUBLE FUN LABORATORY
Big two-door wooden cabinet crammed with chemicals and apparatus. Over 400 spectacular experiments.

Reveals Nature's Secret Colors

They're keen...these Gilbert POLARIZING MICROSCOPES



You open the door to a new wonderland of Nature's hidden colors with a Gilbert Polarizing Microscope. Objects appear 150 times larger. They blaze forth in startling colors never seen with the naked eye or ordinary microscope. Each specimen brings new thrills.

FREE LESSON

See For Yourself How

BE A RADIO

J. E. Smith
President

National Radio Institute
Est. 28 Years

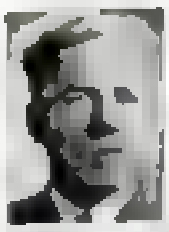
He has directed the training of more men for the Radio industry than anyone else.

Jump Your Pay!

Vital Jobs Go To Men I Train

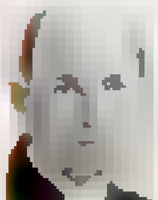
$10 a Week EXTRA in Spare Time

"I am doing spare time Radio Work and am averaging around $500 a year. These extra dollars mean so much — the difference between just barely getting by and living comfortably." — JOHN WASHKO, 97 New Cranberry, Hazleton, Pa.



Chief Operator, Broadcasting Station

"Before I completed your lessons, I obtained my Radio Broadcast Operator's license and immediately joined Station WMPC where I am now Chief Operator." — HOLLIS F. HAYES, 327 Madison St., Lapeer, Mich.



$200 a Month in own Business

"For several years I have been in business for myself making around $200 a month. Business has steadily increased. I have N. R. I. to thank for my start in this field." — ARLIE J. FROEHNER, 300 W. Texas Ave., Goose Creek, Texas.

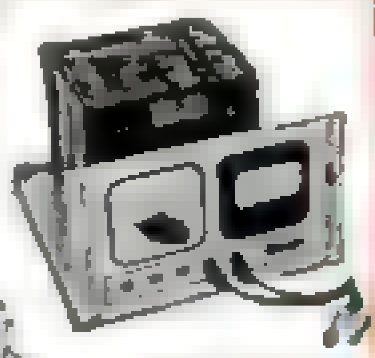
1st Lieutenant in Signal Corps

"I cannot divulge any information as to my type of work, but I can say that N. R. I. training is certainly coming in mighty handy these days." — RICHARD W. ANDERSON (Address omitted for military reasons).

YOU BUILD THESE AND OTHER RADIO CIRCUITS WITH KITS I SEND:

By the time you've conducted 60 sets of Experiments with Radio Parts I supply, made hundreds of measurements and adjustments, you'll have valuable PRACTICAL Radio experience for a good full time or part time Radio job! MEASURING INSTRUMENT (right) you build early in course. Use it in practical Radio work to make EXTRA money. Vacuum tube multimeter, measures A. C., D. C. and R. F. volts, D. C. currents, resistance, receiver output.

SUPERHETERODYNE CIRCUIT (above). Preselector, oscillator - mixer - first detector, i. f. stage, diode detector - a. v. c. stage, audio stage. Bring in local and distant stations on this circuit you build yourself!



A. M. SIGNAL-GENERATOR (left). Build it yourself. Provides amplitude-modulated signals for test and experimental purposes. Gives valuable practice.

Mail the Coupon for a FREE Lesson from my Radio Course. It shows you how practical and easy to understand my lessons are—and why N. R. I. training offers **a quick way to more pay.** And with this free Lesson I'll send my 64 page illustrated book, "Win Rich Rewards in Radio." It describes many fascinating types of Radio jobs, tells how you can train for them at home in spare time!

More Radio Technicians and Operators Now Make $50 a Week Than Ever Before

There's a big shortage of capable Radio Technicians and Operators. Fixing Radios pays better now than ever before. With new Radios out of production, fixing old sets, which were formerly traded in, adds greatly to the normal number of servicing jobs.

Set servicing pays many N.R.I. trained Radio Technicians [illegible]. Others [illegible] make $5 to $10 extra a week fixing Radios in spare time.

Broadcasting Stations, Aviation and Police Radio, and other Radio branches are scrambling for Operators and Technicians. Radio manufacturers, now working on Government orders for Radio equipment, employ trained men. The Government too needs hundreds of competent civilian and enlisted Radio men and women. You may never see a time again when it will be so easy to get started in this fascinating field.

Be Ready to Cash in on Jobs Coming in Television, Electronics

Think of the NEW jobs that Television, Frequency Modulation, Electronics, and other Radio developments will open after the war! You have a real opportunity. Get into Radio NOW and be ready to cash in when Victory releases the amazing wartime Radio developments for peacetime uses!

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

Right now, probably in your neighborhood, there's room for more spare and full time Radio Technicians. Many N. R. I. Students make $5, $10 a week EXTRA MONEY fixing Radios in spare time while learning. I send EXTRA MONEY JOB SHEETS that tell how to do it!

Get Sample Lesson and

Do Unseen Powers Direct Our Lives?

ARE the tales of strange human powers false? Can the mysterious feats performed by the mystics of the Orient be explained away as only illusions? Is there an intangible bond with the universe beyond which draws mankind on? Does a mighty Cosmic intelligence from the reaches of space ebb and flow through the deep recesses of the mind, forming a river of wisdom which can carry men and women to the heights of personal achievement?

Have You Had These Experiences?

. . . . . that unmistakable feeling that you have taken the wrong course of action, that you have violated some inner, unexpressed, better judgment. The sudden realization that the silent whisperings of self are cautioning you to keep your own counsel—not to speak words on the tip of your tongue in the presence of another. That something which pushes you forward when you hesitate, or restrains you when you are apt to make a wrong move.

These urges are the subtle *influence* which when understood and directed has made thousands of men and women masters of their lives. There IS a source of intelligence within you as natural as your senses of sight and hearing, and more dependable, which you are NOT using now! Challenge this statement! Dare the Rosicrucians to reveal the functions of this Cosmic mind and its great possibilities to you.

Let This Free Book Explain

Take this infinite power into your partnership. You can use it in a rational and practical way without interference with your religious beliefs or personal affairs. The Rosicrucians, a world-wide philosophical movement, *invite* you to use the coupon below, now, today, and obtain a free copy of the fascinating book, "The Mastery of Life," which explains further.

USE THIS COUPON

Scribe U.O.T.
The Rosicrucians, AMORC, San Jose, California.

I am sincerely interested in knowing more about this unseen, vital power which can be used in acquiring the fullness and happiness of life. Please send me, without cost, the book, "The Mastery of Life," which tells how to receive this information.

Name..

Address..

The ROSICRUCIANS
(AMORC)

(The Rosicrucians are NOT a religious organization.)

Buy War Savings Bonds and Stamps regularly.

Readers Say:

A Flat End Is the Point This Reader Would Make

IN YOUR October issue, S. E. W. asked why an artillery shell, flat at its back end, is not slowed up by the suction it must create. Because of a screwlike system of lands and grooves in the barrel of a fieldpiece, a torque is imparted to the missile, which causes the air to flow at a tangent to the spinning shell. This tends to compensate for the lack of streamlining In the second place, a shell is propelled from a cannon in the same way as a piston is moved in the cylinder of an internal combustion engine—that is, the explosive, like gasoline, expands when ignited and forces the shell out rapidly. If the end of an auto piston were streamlined, the laws of physics tell us, there would be a faulty resolution of forces, and a smaller output of energy would result. It would be the same with a shell. Furthermore, S. E. W., do you for a moment think that the advantage gained by streamlining the projectile would equal the power of the powder that would be displaced by pointing the end of a shell?—R. C. E., New York, N. Y.

Thanks to All—Especially the Lady

"IT PAYS to advertise!"—especially in P. S. M. My October issue arrived today, and I was amazed at the response to my squib on pipe cleaners. Thanks L. C. B., J. V. S., and A. L. L. for your suggestions. I'll file them away for reference—but that's not all the story. A few weeks ago, I was in my favorite tobacco shop when, to my surprise, the clerk asked me "Are you the E. A. R. from Rye who asked for help on the pipe-cleaner problem in P. S. M.?" After my affirmative answer he brought forth—probably from the safe—six packages of cleaners and asked if that would help any. So I am well supplied at present. But when I run out of them again, I am going to that store at Lexington Ave. and 42nd St. and sincerely hope that "A Red Cross Nurse" will be there buying her favorite brand of cigarettes. I assure her that will be one carton she will only have to say "Thanks" for.—E. A. R., Rye, N. Y.

How Not to Spend A Quiet Sunday at Home

I READ in the October issue that J. G. complains of the results of his attempt to perform the synthetic rubber experiment described in the February, 1940, issue of P. S. M. This issue also gave me a little trouble, but it was the experiment demonstrating oil "cracking" that dealt me a low blow.

I waited until Sunday morning, when everyone had gone to church. Then I set up my apparatus on the kitchen table, put in the mineral oil and the wad of steel wool according to directions, turned on the Bunsen burner, and settled down to what I thought would be several minutes of entertaining and instructive experiment. I had barely started speculating on the possibilities of brewing my own gasoline when there was a gigantic "phwoosh," and various pieces of apparatus shot into the air in several directions. The wad of steel wool, well soaked in hot mineral oil, was propelled like a bullet from the mouth of the test tube and stained the opposite wall for a radius of several inches from where it struck. Coinciding with this, a great cloud of smoke appeared almost miraculously, and quickly spread through the entire apartment. I finally herded it out the windows by running through the house, waving a newspaper.

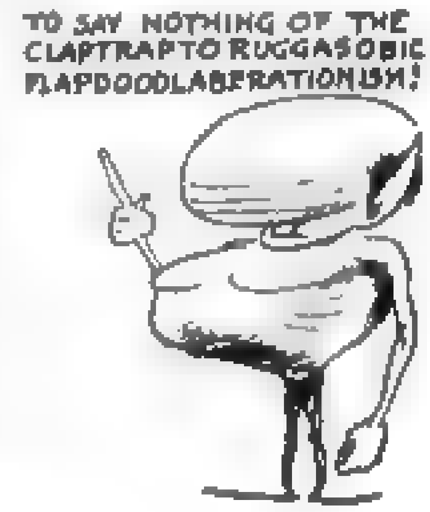
I'm sure other amateur chemists have had results such as this at various times, so why not devote some space to this subject, including if possible, the reasons why these mistakes occurred. Amateur scientists would undoubtedly welcome hints on how NOT to perform an experiment.—C. C., New York, N. Y.

In Australia We Are the "Bonza"

I WOULD like to let you know that P. S. M. interests me more than any other Aussie or American magazine. I've been taking it for 12 months, and it's good to know what America's war effort is like. I only wish we had a magazine to let you in on the Aussie war effort. Keep up those electronic articles—they're bonza! And how about a story on the Australian Light Horse Cavalry before it's disbanded altogether.—M. G., New South Wales, Australia.

As One Planet to Another

THE ARTICLE on Mars in October P. S. M recalled to me what a British writer thought a Martian astronomer might say: "Though we see on Earth some evidence of life, it is probably extremely low. It is impossible to detect . . . any trace of Silkogen, Fologen, Blubdub, Diclorab or Flobrogrupanorbate, without which life as we know it cannot exist. Furthermore . . . all movement would be impossible owing to the Force of Brobnobity"—H. G., Brooklyn, N. Y.



Help Wanted to Get Back in the Groove

I HAVE a number of old Edison phonograph records of the wax type with piano and vocal recordings. They have collected mold through the years, which has spoiled them considerably. I wonder if you know of any way to dissolve the mold or otherwise restore the records.—K. B., Albion, Mich.

Careful, You Bathtub Whirling Dervishes!

ALL P. S. M. readers who are brooding over the direction in which bathwater leaves the tub should know of the man who let whirlpools drive him crazy. It is reported that while conducting an experiment at the equator to determine the direction in which the whirlpools turned, he got dizzy, fell in, and drowned.—W. J., San Antonio, Tex.

He Wants Information for Rocketeers

ON THE whole, your magazine is excellent, but there are not enough articles on the latest developments in rocketry. I realize that much of this work is hush-hush, but you could give us some general information. I urge all P. S. M. fans who are rocket enthusiasts to join the United States Rocket Society.—R. G., Norfolk, Va.

Readers Say:

For It's Always Odd Weather When Congress Gets Together

I ADMIT that I don't have a pattern for the all-weather coat requested by W. P. C., a lifetime resident of Washington. I wonder though if he knows why the nation's capital is subject to such changeable weather. I've concluded that since our Congressmen come from all sections of the country—hot, cold, dry, damp—the weatherman leans over backward to make them feel at home. By giving them samples of the weather prevailing in their native states, he keeps scores of senators and representatives from getting homesick. Ain't it somethin' when even the weatherman in Washington is a "yes man"?—L. D. K., Rochester, N. Y.

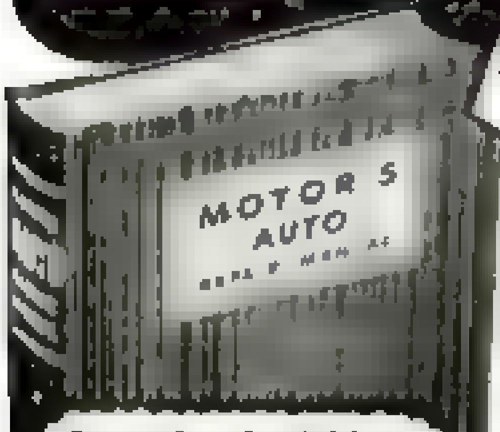
Who Was That Mermaid We Saw You With Last Night?

READER L. S. says in the October issue that he knows a few facts about the sinking of the *Titanic*. Will he kindly explain who measured the 310-foot hole that the iceberg is supposed to have cut into the bow of the liner, and whether it was a square or round hole, or just a 310-foot gash an inch or so wide. Of course, the liner was not large enough to accommodate a 310-foot-square hole, but the fact that he is so positive about the size of the hole makes one wonder how that dimension was obtained. He further writes that 11 watertight compartments, besides the five that had been ripped open, slowly filled—the stern finally rising out of the water until the boat was almost perpendicular, and at that point all heavy machinery fell forward and probably tore a hole in the bow. How did the water get into the 11 compartments if they were actually watertight? And how could heavy machinery fall forward when such parts are anchored and bolted down in a most secure manner? Furthermore, if the boilers, etc., had ripped loose from their foundations, the impact from the falling mass would not have been great enough to rip another hole in the bow, at least not in a ship of such heavy steel construction.—E. F. W., Riverside, Ill.

Free 7-Day Offer!

AUTO MECHANICS!

REPAIR ANY MAKE CAR—TODAY!



Explains Every Repair Job on Every Model of All These Cars — 1935 through 1942!

American Bantam; [illegible] Lincoln Zephyr; Mercury; [illegible] Drawings, Diagrams. [illegible] Published by MoToR. The Leading Automotive Business Magazine.

Helps EVERY Mechanic—even experts—do repair jobs easier, quicker

Explains every auto repair operation STEP-BY-STEP. Easy-to-use! Hundreds of photographs, diagrams, drawings, show exact "how to do it" of repairs, adjustments, replacements. *All* jobs on *every* model since 1935! Engine; Electric, Fuel, Cooling, Lubrication Systems, Clutch, Transmission; Universals; Rear End; Wheels, Brakes; Knee Action, Shock Absorbers, Springs, Body; Free Wheel Overdrive, Fluid Coupling!

150 FACTORY BOOKS IN ONE!

Imagine a COMPLETE COLLECTION of ALL official shop procedure manuals, prepared by each car manufacturer's own engineers! That's what you GET in this book! Open the manual to the car you want—you'll find everything to show the *right* way to do the job. This is the factory shop manual used by the U. S. Army, trade, technical and vocational schools.

Same FREE 7-Day Offer MoToR's Truck Repair Manual!

1400 pictures. 905 pages. 300,000 facts. Used by U. S. Armed Forces. Strong Fabrikoid binding, size 8½x11. Covers 10,000 models, 1936-1942. All Gasoline Engines, ALL DIESELS, Hesselmans, Diesel Fuel Injection Systems, etc., etc.

SEND NO MONEY

Simply fill out coupon below. Mail it today and a copy of MoToR's up-to-the-minute New Auto Repair Manual will be sent to you at once for 7 days Free Examination.

MoToR Book Dept., Desk 212, 572 Madison Ave., New York 22, N. Y.
Rush to me at once: (check box opposite book you want).

☐ **MoToR's AUTO REPAIR MANUAL** (*formerly "MoToR's Factory Shop Manual"*). If O.K. I will remit $1 in 7 days, $1 monthly for 4 months, plus 35c postage with final payment ($5.35 in all). Or I'll return book in 7 days. (Foreign, remit $7 with order.)

☐ **MoToR's TRUCK REPAIR MANUAL.** If O.K., I will remit $2 in 7 days, $2 monthly for 3 months, plus 35c postage with final payment ($8.35 in all). Or I'll return book in 7 days. (Foreign, remit $11 with order.)

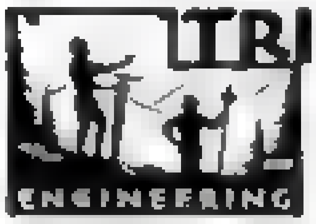
Name________________ Age______
Address________________
City________________ State________

☐ Check here if enclosing full payment. WE pay 35c postage. Same 7-Day Return Privilege.

Wanted! New Products!

Long-established and well-known company with modern plant for production of precision devices wants new products for post-war manufacture. Particularly interested in small and medium-sized motor-operated tools or appliances. Ideas need not necessarily be completely developed. Send only description of product, indicating purpose, market and advantages for complete, prompt, and confidential consideration. If your idea has possibilities, and will fit into our plans, further arrangements can then be made. Address Research Department.

The Dumore Company, Racine, Wisconsin



TRI-STATE COLLEGE

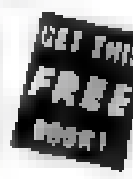
B. S. Degree in 27 Months

Distinguished for technical 2¼-year courses in Civil, Electrical, Mechanical, Chemical, Radio, Aeronautical Engineering, Business Administration, Accounting and Secretarial Science. **MEN AND WOMEN**—3 yr. high school students with good record admitted. Special Preparatory Department. Modern laboratories, latest equipment. Low tuition. Low living costs. Cosmopolitan student body. 60th year. Enter January, March, June, September. *Write for catalog.*

5123 College Ave. ANGOLA, INDIANA

STAMMER?

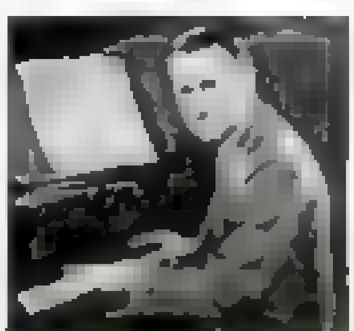
This new 128-page book, "Stammering, Its Cause and Correction," describes the Bogue Unit Method for scientific correction of stammering and stuttering—successful for 42 years. *Free—no obligation.* Benjamin N. Bogue, Dept. 1858, Circle Tower, Indianapolis, Ind.



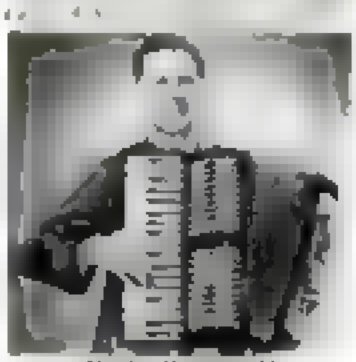
IT'S REALLY FUN

LEARNING MUSIC WITHOUT A TEACHER

—this easy way



Learned Quickly at Home



Well Worth It

OVER 750,000 students have enrolled for this home study method. Many didn't know one note from another—yet they started in learning simple tunes by note. For this wonderful method makes it easy as A-B-C to learn music at home, without expensive private lessons. No tedious study and practice. Every step is right before your eyes in print and pictures. You can't go wrong. Soon you are actually playing popular pieces on your favorite instrument.

FREE Print and Picture Sample

See how easily you may learn to play your favorite instrument in spare time at home at amazingly low cost. Mail coupon today. Address U. S. School of Music, 812 Brunswick Bldg., New York No. 10, New York.

U. S. School of Music, 812 Brunswick Bldg., New York 10, N. Y.
Please send me FREE Print and Picture Sample and Illustrated Booklet. I am interested in the instrument checked below.
(Do you have instrument?.............................)

Piano	Piano Accordion	Tenor Banjo
Guitar	Saxophone	Modern Elementary Harmony
Violin	Trumpet, Cornet	Other Instrument

Name..............................
(Please Print)
Street..............................
City.............................. State..............

*Actual pupils' names on request. Pictures by professional models

New!

COYNE "Learn-by-Doing" Shop Course
RADIO *Communications* *and* ELECTRONICS

GET READY NOW FOR A GREAT VICTORY FUTURE

I'll Finance Your Training

War has created tremendous opportunities for men in RADIO OPERATING AND ELECTRONICS. Here is the practical "Learn-by-Doing" shop training in this big field. Not by correspondence, but actual experience on real Radio and Electronic apparatus.

START NOW—PAY LATER!

I make it easy for you to come to Chicago for my practical training. Don't let lack of money hold you back! You can pay tuition AFTER YOU GRADUATE. I'll even help you secure part-time work while at Coyne to help pay living expenses. My plan has aided thousands—coupon brings complete details.

Prepares for Gov't License

Many of the better Radio jobs require U. S. Govt. license. Coyne has prepared hundreds of men for this test. Our graduates hold good positions in broadcast stations, air transport, police radio and motion picture studios.

You'll Receive Personal Instructions on Fascinating Radio and Electronic Apparatus

It's the thrill of a lifetime when you first operate the amazing variety of up-to-the-minute Radio and Electronic equipment at Coyne! Experts show you each step, train you thoroughly. You'll learn to send Code rapidly—do actual trouble-shooting on Television, short-wave and electronic devices. With this training you get my LIFETIME EMPLOYMENT SERVICE. I train you for a real job, then help you get it!

H. C. LEWIS, President

COYNE ELECTRICAL SCHOOL RADIO DIVISION

500 S. Paulina Street, Dept. 93-4H, Chicago, Ill.

SEND FOR MY FREE BOOK!

Find out all about the sensational new future for Coyne-trained Radio Operators and Industrial Electronic Specialists. My FREE BOOK is full of photos and job information. There's a place in this vast field for YOU. Age, lack of experience bars no one. Coyne has been training men 44 years—is nationally famous. Act now. Use handy coupon. No obligation, no salesman will call. Don't delay. Send it today!

Get the FACTS!

See How Easily YOU can get my Radio Shop Training!

MAIL COUPON

H. C. LEWIS, Pres.,
RADIO DIVISION
COYNE ELECTRICAL SCHOOL, Dept. 93-4H
500 South Paulina St., Chicago, Ill.

Without obligating me, send your FREE BOOK, "Your Future in RADIO", and tell me about your "Pay-After-Graduation" plan.

NAME ....

ADDRESS ....

CITY .... STATE ....

SHEET METAL INFORMATION

SIZE 7" x 10" x 2"
1125 PAGES

ON LAYOUTS

NOW READY!

A practical, illustrated Encyclopedia covering all phases of Sheet Metal Work including Pattern Cutting, Pattern Development, and Shop Procedure—Developed by experts for Sheet Metal Workers, Layout Men, Mechanics, and Students.

1001 KEY FACTS AT YOUR FINGER ENDS

10 Big Sections, 350 Layouts, 1600 Illust.

FULLY INDEXED FOR READY REFERENCE in answering your layout problems. Easy to read and understand. Well printed in clear type. Flexible covers.

$4 COMPLETE • PAY ONLY $1 A MO.

To get this assistance for yourself simply fill in and mail order today.

AUDEL, Publishers, 49 West 23rd St., New York

Mail AUDELS SHEET METAL PATTERN LAYOUTS BOOK. Price $4 on 7 Days Free Trial. If O. K. I will remit $1 in 7 days and $1 monthly until $4 is paid. Otherwise I will return it.

NAME ______________________

ADDRESS ______________________

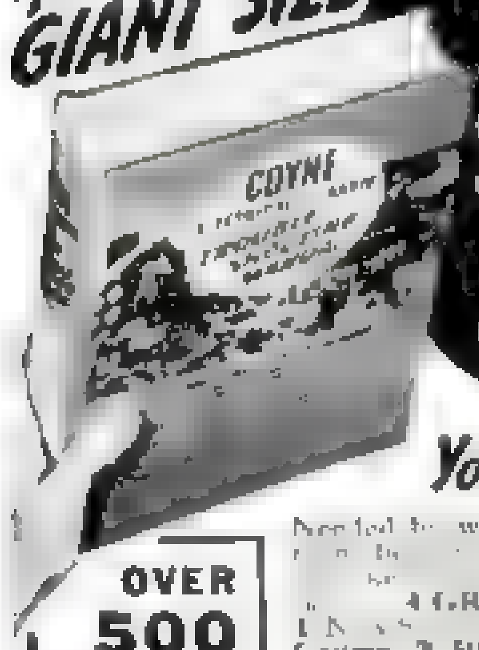
OCCUPATION ______________________

REFERENCE ______________________ PSM

ELECTRICIANS! RADIO MEN!

Earn More Money!

Get this new GIANT SIZE



ELECTRICAL and RADIO TROUBLE SHOOTING MANUAL

GUARANTEED BY COYNE

Yours 5 Days Free

OVER 500 Large Size Electrical and Radio Shop Prints -How to read and use them

[illegible] **4 GREAT BOOKS IN ONE!** 1. [illegible] Course. 2. 500 Shop Prints. 3. Elec-Radio Dictionary. 4. Spare Time Jobs.

FREE! 1 yr. Technical Counsel by mail from COYNE staff, on trouble shooting problems.

SEND NO MONEY! See offer below. Satisfaction guaranteed by famous COYNE "Learn-by-Doing" Electrical School. Rush coupon now!

H. C. LEWIS, Pres., Dept. 93-4
COYNE ELECTRICAL SCHOOL
500 S. Paulina St., Chicago 12, Ill.

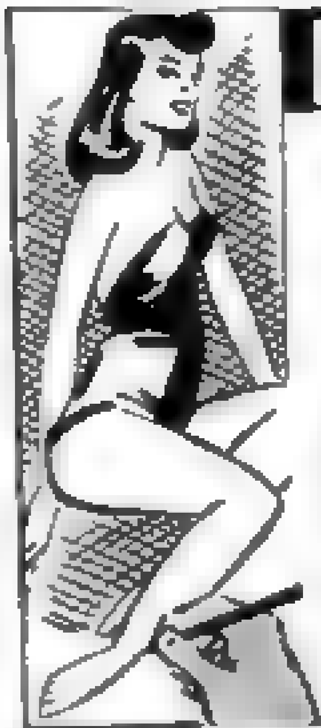
FREE TRIAL COUPON

Send, with all shipping charges paid, your new COYNE Electrical and Radio Trouble Shooting Manual. Within 5 days after getting, I'll either return it or send $2, then $3 monthly until total of $8.95 is paid. Cash price $5.95—you save over 10%. Same 5-day free trial and return privilege.

NAME ______________________

ADDRESS ______________________

CITY ______________ STATE ______



DRAW for MONEY

Be An ARTIST!

PREPARE TODAY FOR THE FUTURE THAT LIES AHEAD

Trained Artists Are Capable of Earning

$30-$50-$75 A WEEK

Use your spare time to prepare for a profitable Art career! Start training at home, now!

It's pleasant and interesting to study Art the W. S. A. way. **COMMERCIAL ART, DESIGNING, CARTOONING**—all in ONE complete course. No previous Art experience necessary—we teach you step-by-step by our practical home study method that has trained thousands since 1914. Write today for information in FREE BOOK, "Art for Pleasure & Profit," tells all about our course, service—and commercial opportunities for you in Art. State age.

WASHINGTON SCHOOL OF ART

Suite 1312-F, 1115-15th St., N.W., Washington 5, D.C.

Earn $60-$100 Per Week in ELECTRICITY

Our [illegible] METHOD of ELECTRICAL INSTRUCTION trains you for PRACTICAL work in GOOD PAY JOBS in less time and at less cost. Just a few weeks of spare time study prepares YOU!

ACT NOW! A penny postal will bring complete details and prices FREE.

SUNBURY ENGINEERING WORKS
BOX 139, DEPT. 6-12 SUNBURY, PA.

DRAFTING

MORE DRAFTSMEN NEEDED in all manufacturing and [illegible] to $50 a week and UP. [illegible] at home in spare time. Selective [illegible] Write NOW for FREE [illegible]. No obligation.

American School
Dept. DD946, Drexel at 58th, Chicago 37

LAW

[illegible] AT HOME for PERSONAL SUCCESS and LARGER EARNINGS. 31 years expert instruction—over 100,000 students enrolled. LL.B. Degree awarded. All texts furnished. Easy payments. Send for FREE BOOK—"Law and Executive Guidance".

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 30-6, 8 East Huron St., Chicago, Ill.

MECHANICAL DENTISTRY

A profession offering unlimited opportunities. [illegible] Work [illegible] prepares you to work for [illegible] night school. [illegible] upon request.

McCARRIE SCHOOL OF MECHANICAL DENTISTRY
207 N. Broad St. Dept. 821 Philadelphia, Pa.

MENTAL SCIENCE

Awaken Your Hidden Powers!

You are a sleeping giant . . . learn how to release your unused forces. New really practical reading course in everyday psychology. Teaches you self mastery, influencing others, getting ahead, etc. Written by 14 psychologists. Low price. Satisfaction guaranteed. FREE DETAILS, write today! Nelson Co. 321-M Wabash Ave. Dept. 600 Chicago.

RHEUMATISM

ARTHRITIS - NEURITIS - SCIATICA

Why continue to suffer the agonizing pains of these diseases when the usual remedies have failed? Learn about a new trustworthy, modern, non-surgical treatment method. This marvelous treatment is completely explained in the Ball Clinic's FREE Book. Write today. No obligation.

BALL CLINIC, Dept. 5100, Excelsior Springs, Mo.

WILL YOU WEAR THIS SUIT

and Make up to $12 in a Day!

You can get this fine, tailored-to-measure suit for yourself without paying one penny cash, by taking a few orders from friends. My plan also helps you make up to $12 in a day without experience or house-to-house canvassing. Big opportunity—full or spare time.

Send for Samples—FREE! Write today for FREE CLOTH SAMPLES and "sure-fire" money-making plans. For quick action write fully giving age, etc. Send no money. **H. J. Collin, PROGRESS TAILORING CO., 500 So. Throop St., Dept. Z-221, Chicago, Ill.**

RICH REWARDS FOR THOSE WHO KNOW PLASTICS

BE A PLASTICS TECHNICIAN

Do you want action [illegible] a vital growing war-time industry . . . helping to turn out fighting planes and jeeps and bombs and tanks? There's a big demand for men and women plastics technicians to fill important war industry positions [illegible] and if you start your training now—at home—you may qualify for a place in this vital part of the war program

LOOK TO THE FUTURE

Even more important is the question—what will you do when the war is over? Will you be among those fighting for jobs that may no longer exist? *Or will you be well on your way to a permanently profitable career, or established in your own business, with plastics?*

Build your personal post war plans on a sound knowledge of plastics. This country is already in the Plastics Era. The future of the plastics industry is so rich that some predictions seem exaggerated and fantastic . . . but the fact remains that plastics have proven themselves and are vital in the production of airplanes, autos, furniture, radios, trains, clothing, electrical appliances and equipment, machinery, tools, and hundreds of other products.

CHOOSE YOUR FIELD . . . *Enter it thru PLASTICS*

You should be able to see for yourself what plastics will mean in virtually every field—the possibilities that will be available to those trained in plastics. Now is the time to prepare for your chosen field, as a plastics technician.

LEARN AT HOME

Make your increased hours at home pay you dividends. You can easily fit into your spare time your training for a career in plastics. You won't need to lose one minute from your present work . . . simply devote a few hours each week to enjoyable home study, like thousands of other men and women are doing who are helping their country while helping themselves. The Plastics Institute course is an easy, practical tested method which will help fit you for this promising and interesting field . . . and if you are now working with plastics, it equips you for advancement. During the entire course your training is supervised by men well known in the plastics industry, in which they have been recognized as authorities for years.

STUDENTS REPORT SUCCESS

"I wish to acknowledge, with thanks, the receipt of my final examination papers, my certificate of graduation, and the lesson binders you sent me

"I have really enjoyed your excellent course of study, and the friendly help and cooperation you have given me, and feel that the time and money expended on my training has been well worthwhile

R.F.P.

TIME IS PRICELESS—*ACT NOW!*

Find out how the Plastics Institute can help YOU. Mail the coupon for your copy of the large FREE, illustrated booklet, the "World of Plastics." It is crammed with valuable information about plastics, tells about the new plastic airplanes and other uses for this revolutionary new material . . . as well as about the opportunities for YOU in plastics. Decide NOW to let plastics point the way to YOUR success . . . send the coupon TODAY

Plastics INDUSTRIES TECHNICAL INSTITUTE

AMERICA'S ORIGINAL PLASTICS SCHOOLS

1220-D Chanin Bldg.	626-D LaSalle-Wacker Bldg.	194 So. Alvarado St.
New York	Chicago	Los Angeles

MAIL COUPON FOR FREE BOOK

Plastics Industries Technical Institute
626-D La Salle-Wacker Bldg., Chicago

Gentlemen Please send me the booklet "World of Plastics" and information on your training program. I understand there is absolutely no obligation.

Name________________________Age______

Street________________________________

City_____________________State________

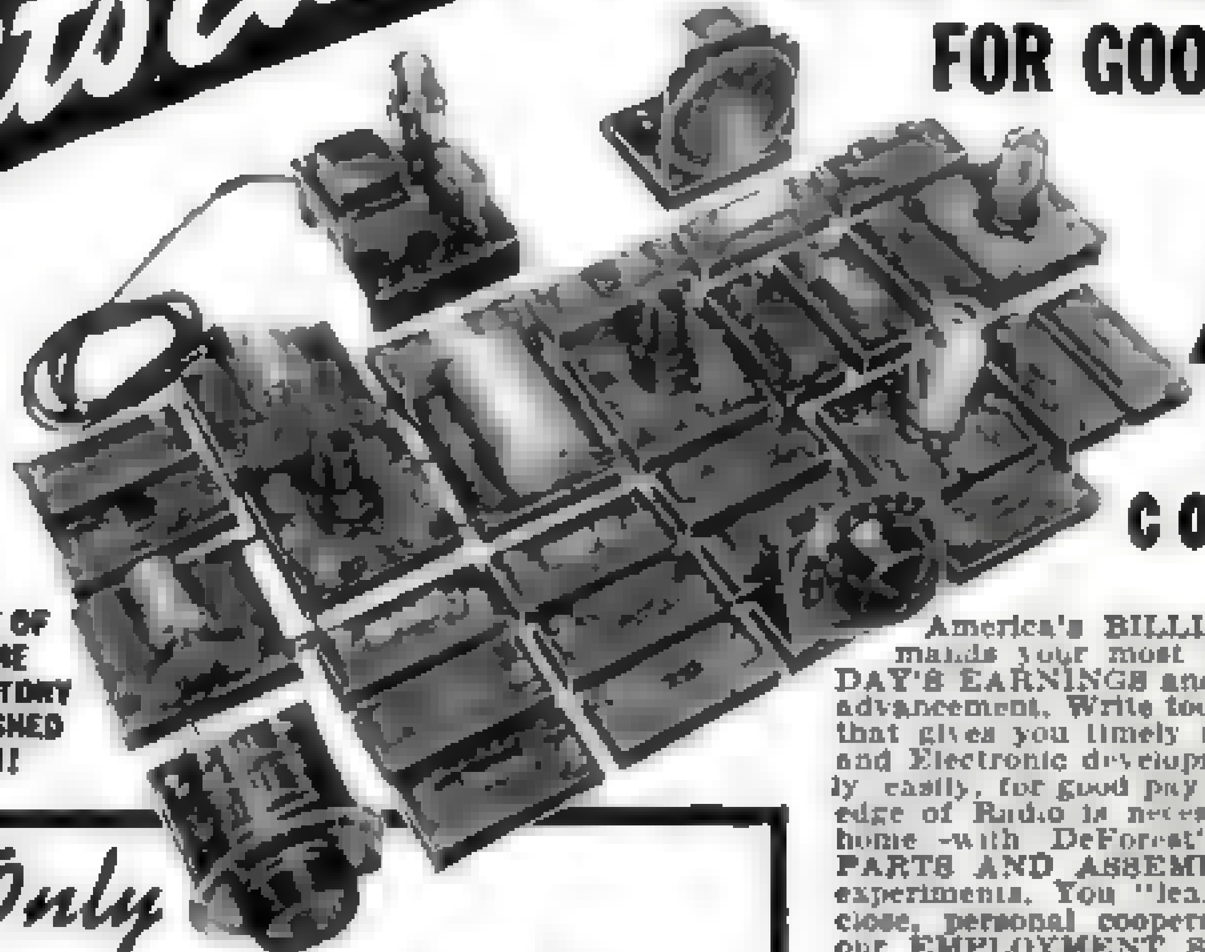
Dept.12

Now it's Easy! PREPARE YOURSELF

WITH THIS EQUIPMENT AT HOME FOR GOOD PAY JOBS IN

RADIO

ELECTRONICS COMMUNICATIONS

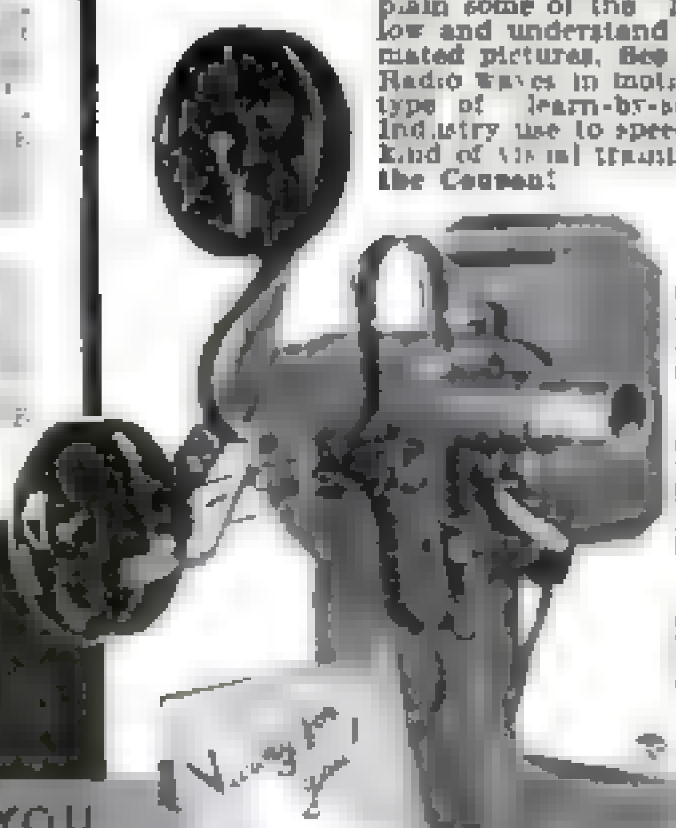


PART OF HOME LABORATORY FURNISHED YOU!

America's BILLION DOLLAR RADIO INDUSTRY demands your most thoughtful consideration for both TODAY'S EARNINGS and TOMORROW'S OPPORTUNITIES for advancement. Write today for DeFOREST'S BIG FREE BOOK that gives you timely facts about present and postwar Radio and Electronic developments. See how you can prepare quickly, easily, for good pay and advancement. No advanced knowledge of Radio is necessary. You get practical experience—at home—with DeForest's 8 VALUABLE KITS OF RADIO PARTS AND ASSEMBLIES. You work out 133 fascinating experiments. You "learn-by-doing." Our instructors give you close, personal cooperation. When your course is completed our EMPLOYMENT SERVICE gives you the benefit of its close contact with Industry. But that's not all:

You "Learn-by-Seeing"—with Home Movies

Learning is FUN with DeForest's HOME MOVIE METHOD. More effective! Easier! Faster! You show dramatic ACTION PICTURES—films that take you behind the scenes—clearly explain some of the "hidden activities" of Radio. Follow and understand hidden action by means of animated pictures. See Electrons on the march. Watch Radio waves in motion. Take advantage of the same type of "learn-by-seeing" method Uncle Sam and Industry use to speed training. Don't wait! Get this kind of visual training NOW—from DeForest's. Mail the Coupon!



Only

DeFOREST GIVES YOU THIS BIG 3-WAY COMBINATION

Mail coupon today for your big, interesting Radio book

DEFOREST'S STUDENTS GET THE "BREAKS"

"I wish to express my sincere thanks for your help in obtaining my new job. Your employment service is working wonders. I like the work and also the place and people. I feel indebted to you for your efforts."
—*James M. Smith, Ohio*

"Your course was the only important training I received in order to make the transition from a Radio-telegrapher earning \$1,800 a year to Radio Engineer with a salary that has been \$2,700 minimum and \$4,200 maximum besides extra allowances."
—*Samuel Freedman, Conn.*

"My radio repair shop is in the cellar of my home. I operate it as a full time job. Am not employed elsewhere. My highest week brought in \$148.00 since I took DeForest's Training."
—*Henry C. ..., Brooklyn, N. Y.*

DeFOREST'S TRAINING, INC.
CHICAGO, U.S.A.

LET THEIR EXPERIENCE GUIDE YOU

Dr. Lee DeForest ... the Preparation of DeForest's Training

PUT YOURSELF IN THIS PICTURE

Dr. Herman A. DeVry ... Pioneer ... DeForest's Training

DeFOREST'S TRAINING, INC.,
2535-41 N. Ashland Ave., Dept. H, Chicago, U.S.A.
Please send me—FREE and WITHOUT OBLIGATION—your illustrated book, "VICTORY FOR YOU!" showing me how I can get your Home-Movie Training and Home-Laboratory Kits.

Name ________ Age ____

Address ________

City ________ State ____

Mail this Coupon

For You 12 Months of Thrilling SCIENTIFIC EXPERIMENTS

For $10.00

Each month for one whole year, SCIENCE SERVICE the national Institution for the Popularization of Science in Washington, will mail to you an exciting scientific unit—"FUNdamentals of Science." When you open it, you'll be in for a thrilling experience. There—ready to handle and experiment with—will be actual specimens of scientific objects—uncovering nature's hidden secrets. With each unit are simple, amazingly interesting and complete explanations.

A Whole Year of Thrilling Adventures in Science—Right at Home

"FUNdamentals of Science"—Unit No. 1—will arrive by return mail. Then, each month for the next eleven months you'll receive new and thrilling "surprise" packages—each unit complete—nothing else to buy. The actual experiments you do at home will make science "live" for you as never before.

Subscriptions Limited So Mail Coupon TODAY

But subscriptions to "FUNdamentals of Science" are limited, so mail the coupon TODAY. (Incidentally it will make a wonderful Christmas gift for special friends.)

SCIENCE SERVICE

Organized 1921 as a non profit educational institution, with trustees nominated by the [illegible] Academy of Sciences, Nat'l Research Council, the Amer. Ass'n for the Advancement of Science, E. W. Scripps Estate and the Journalistic Profession. WATSON DAVIS, DIRECTOR 1719 N Street, N. W., Washington 6, D. C.

SCIENCE SERVICE
1719 N Street, N. W., WASHINGTON 6, D. C.

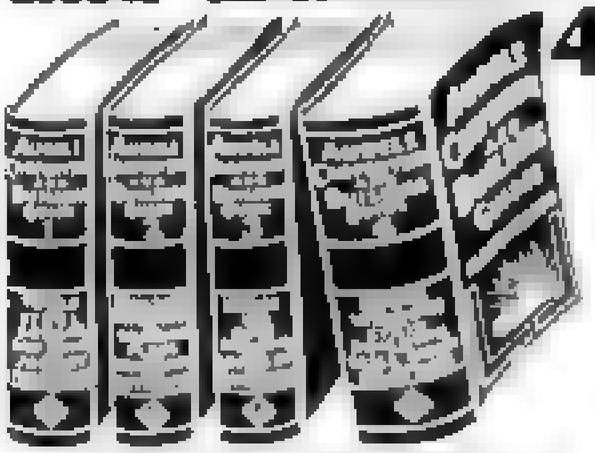
Attached is (money order / check) for .... Please enter my name for your 12 month Gift Subscription to "FUNdamentals of Science" at $10 per annual subscription.

Name ....
(Please Print)
Address ....
City .... State ....

(Note: If you want "FUNdamentals of Science" to be sent as a Christmas gift to your friends, attach to this coupon a list with their names and addresses and include in your remittance $10 for each name.) 2 W 73

A USEFUL XMAS GIFT!

AUDELS Carpenters and Builders Guides 4 vols. $6



Inside Trade Information for Carpenters, Builders, Joiners, Building Mechanics and all Woodworkers. These Guides give you the short-cut instructions that you want—including new methods, ideas, solutions, plans, systems and money saving suggestions. An easy progressive course for the apprentice and student. A practical daily helper and Quick Reference for the master worker. Carpenters everywhere are using these Guides as a Helping Hand to Easier Work, Better Work and Better Pay. To get this assistance for yourself, simply fill in and mail the FREE COUPON below.

Inside Trade Information On:

How to use the steel square—How to file and set saws—How to build furniture—How to use a mitre box—How to use the chalk line—How to use rules and scales—How to make joints—Carpenters arithmetic—Solving mensuration problems—Estimating strength of timbers—How to set girders and sills—How to frame houses and roofs—How to estimate costs—How to build houses, barns, garages, bungalows, etc.—How to read and draw plans—Drawing up specifications—How to excavate—How to use settings 12, 13 and 17 on the steel square—How to build hoists and scaffolds—skylights—How to build stairs—How to put on interior trim—How to hang doors—How to lath—lay floors—How to paint

THEO. AUDEL & CO., 49 W. 23rd St., New York City

Mail Audels Carpenters and Builders Guides, 4 vols., on 7 days' free trial. If O.K. I will remit $1 in 7 days, and $1 monthly until $6 is paid. Otherwise I will return them. No obligation unless I am satisfied.

Name ....
Address ....
Occupation ....
Reference .... PSM

don't WORRY

Why put up with years of needless discomfort and worry? Try a Brooks Automatic Air Cushion. This marvelous appliance permits the opening to close, yet holds reducible rupture securely, comfortably—day and night. Thousands report amazing results. Light, neat-fitting. No hard pads or stiff springs to chafe or gouge. Made for men, women and children. Durable, cheap. **Sent on trial** to prove it. Never sold in stores. Beware of imitations. Write for Free Book on Rupture, no-risk trial order plan, and proof of results. All correspondence confidential.

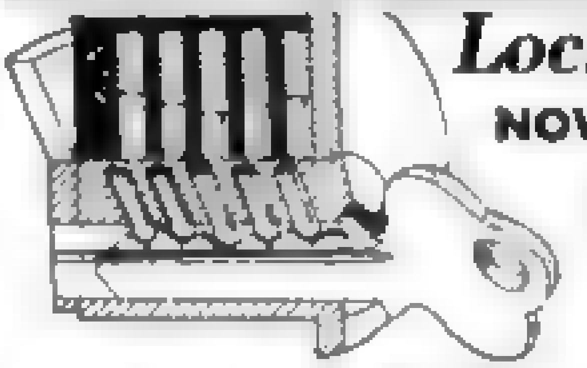
BROOKS COMPANY, 160-C State St., Marshall, Mich.

Got a HOT idea?

OR A SWELL GADGET?

Let's get together—our Engineering and Production Staff and our Unlimited Financing will develop and promote your brain-child for P. W. P., and arrange for patent. You are fully protected—Specializing in Plastics, Electronics, Metal or Wood. Write Today.

ADDRESS DEPT. G BOX 2745, KANSAS CITY, MO.



Locksmithing NOW MADE EASY!

New course for practical men, mechanics, carpenters, fix-it shops, etc. Learn to fit keys, pick locks, de-code, make masterkeys. It pays. Send name for FREE details. No obligation — write today!

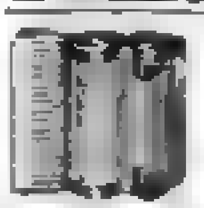
Nelson Co., 321 S. Wabash, Dept. M-703, Chicago.

THINK and forge ahead FASTER

Today ... my fast Mind-Training System, discover new powers in your mind, locate opportunities, win years' advancement in months.

MIND-POWER TEST FREE while supply lasts

Dr. Frank Tibolt, 99A Fern St., Philadelphia



ITALIAN ACCORDIONS

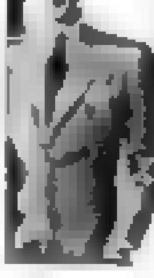
HAND MADE. Very best. Lowest prices. Buy direct from Factory and save money. Send name and address for FREE catalog.

ITALIA & P. SOPRANI ACC. MFG. CO.
323 W. POLK ST., DEPT. PS-12 CHICAGO, ILL.

JOKE BOOKS FOR ADULTS

The kind they like. You will be both a Riot and the Life of the Party with a set of these pocket size joke books. They are full of Entertainment, Fun and Humor. A set of six books only 50c or a special assortment of 12 books all different for $1.00. Print name and address, send cash or stamps to:

TREASURE NOVELTY CO.
72-5th Ave., Dept. 1412, N. Y. 11, N. Y.



If I Send YOU THIS SUIT FREE AS A BONUS—

Will You Wear It and Show It to Friends?

I need a reliable man in your town to wear a fine made-to-measure, all wool DEMONSTRATING SUIT—advertise my famous tailored clothing and take orders. You can make up to $12.00 in a day. My line contains over 100 quality fabrics, all sensational values, guaranteed. You need no experience or money. I supply everything required FREE. Write today, telling about yourself, age, etc., for FREE OUTFIT.

STONEFIELD, 1300 W. Harrison, Dept. Z-821, Chicago

Buy War Savings Bonds and Stamps regularly.

Classified Opportunities

Classified Ads only 35c per word per insertion, payable in advance. Minimum ad 10 words. To be included in February issue copy should be in our office by December 6th. February issue on sale January 3rd.

POPULAR SCIENCE MONTHLY—351 FOURTH AVE.—NEW YORK CITY 10

ADVERTISING

MAIL-Order or agent ad reaching 1,000,000 families throughout United States $15.00 inch. Newspaper, magazine, mailing list, ratebook, free. Chicago Advertising Agency, 20-SP West Jackson, Chicago.

CARTOONS for your Advertising. Up to 3 square inches $1.00. Send dollar with copy to Henry Littlejohn, Box 22, Greenville, South Carolina.

ADVERTISE 24 words 148 newspapers, $6.50. Lists Free. Advertising Bureau, 4515-P Cottage Grove, Chicago 15.

24 WORDS 35 newspapers $2.00. Goodall, 37 Gardner, Vallejo, California.

AGENTS WANTED

EVERYONE With Anyone in the Service wants a Personalized Honor Scroll and Service Record. Timely, fast sellers, profitable. Complete data on request or $2 gets Sales Kit with samples and this amount refunded upon return of Kit or after $20 sales. Harry F. Lutz Service, 242 West 55th Street, N. Y. 19, N. Y.

AMBITIOUS School Seniors—Sell Classmates the "tops" in Graduation Name Cards. Best Commissions. Free Cards. Agencies going like wildfire. Hurry! Craftcards. Box 235-M, Pittsburgh 30, Pa.

SCHOOL Seniors—Sell America's most beautiful, distinctive Graduation Name Cards. Positively highest commission. Lowest prices. Free sample kit. Printcraft, 1423 East Elm Street, Scranton, Pa.

SILVER Plating and Polishing Liquid. Apply with cloth. Cleans, silverplates, polishes, one rubbing. Renews silverware, jewelry, musical instruments, automotive trim, etc., like new. $1.00 bottle postpaid. Nu Silver, Aurora, Ill.

GOOD Paying Business Silvering mirrors, plating autoparts, reflectors, bicycles, bathroom fixtures, etc., by late method. No tanks or shop required, outfit furnished. Free sample. Gunmetal Co., Ave. G., Decatur, Illinois.

EXCELLENT Sideline for Printing Salesmen. Decalcomania Name Plates in small quantities. Also, make money applying Initials on Automobiles. Free Samples. "Ralco", 1443 Washington, Boston (18), Mass.

TAKE orders for new, sensational Plastic Lifetime Reproductions of any photo or negative. Amazingly beautiful. Big earning opportunity. Part or full time. Get details quickly. Quaker Service Co., 914 Walnut St., Philadelphia, Pa.

BIG Money taking orders; Shirts, Ties, Sox, Pants, Jackets, Sweaters, Shoes, Uniforms, etc. Sales Equipment Free. Experience unnecessary. Nimrod, 4922-AV Lincoln, Chicago.

AGENTS—Coin Money—It's New. It's Hot! Everyone wants radiant plastic plaques of loved ones. Commissions advanced. We deliver. Collect. Kondon, Box 157, Upper Darby, Pa.

PURE Air assures greater comfort, better health, increased production less fatigue. Ionaire Unit easily installed anywhere. Low cost. Write for details. Elmer Goodson, Clarston, Wyoming.

SEND stamp for bargain sheet on 30 useful Xmas gift items from 25c to $12.50. Goldsheid Products, Dept. S, 150 Greenwich Street, N. Y.

SCIENTIFIC Manufacturing Processes. Simplified! Profitable! Trade Secrets! Profits to 1,500%. Lists free. Thermobish, Peoria 6, Ill.

AGENTS—100% Profit selling Gold Leaf Window Letters, stores and offices. Free samples. Metallic Letter Co., 437 N. Clark, Chicago.

LICK After-war layoffs! Start own business home, office. Booklet describing "Collection of 127 Tested Plans" free. Elite Co., 214A Grand St., New York.

WINDOW Sign Letters—Large Sizes. Penny Each. Beautiful (Glass mounted) Samples Free. Stamp Appreciated. Atlas, 7941 S. Halsted, Chicago.

FREE Water and our concentrates makes flavors, lotions, shampoos. 72 products, labels, bottles furnished. Qualco, F-20030 Russell, Detroit.

MAGIC Shopping Bag. Sells like wild. Magically turns purse into roomy shopping bag. Handy, compact. Samples sent on trial. Kristee 130, Akron, Ohio.

PIN-UPS. Patriotic, Military Items. Jewelry. Wholesale. Samples $1.00. Clarer, Hollis 7, New York.

BIG Money selling 25c Catarrh Remedy. CSPCo., 8673 80th St., Woodhaven, N. Y.

MEN'S Sundries. Blades, Catalogue, List 1c. Houck Products, Tiffin, Ohio.

FREE wholesale lists of novelties and books. Torrance, Hampton, Virginia.

PLAYING card game, 350% profit. Sample game 25c. Box 842, Denver 1, Colorado.

AMERICAN POLICE JIU JITSU

AMERICAN Jiu Jitsu—A New Revised Course by World's most famous Jiu Jitsu Instructor who for more than 20 years has taught his methods to thousands in U. S. Army, Navy, Marines, National Guard, Coast Guard, R. O. T. C., Customs, Border Patrol, Police, Sheriffs and civilians. Complete course of 14 spare time lessons, 60 illustrations, 35 secret knockout and death blows without use of fists, disarming persons with knife, gun or club and many more tricks. Full price 25c coin or 30c in stamps. S. J. Jorgensen, 444 Maritime Bldg., Seattle 4, Wash.

ANTIQUES, RELICS INDIAN GOODS

278 ANTIQUE Firearms, Swords, Cartridges, Rifles, Indian Relics. Catalog, 10c (Photographs of Most). Heike, Wenona, Ill.

PREHISTORIC Stone Tomahawk $1.00, 100 good Prehistoric Arrowheads $3.00. List free. Lear's, Glenwood, Arkansas.

SWORDS, rapiers, daggers, pistols, armor, illustrated catalog 25c. Robert Abels, 860½ Lexington Ave., N. Y.

INDIAN Relics, coins, minerals, glass buttons, catalogue 5c. Vernon Lemley, Osborne, Kansas.

25 GENUINE Indian Arrow heads, $1.00. Catalog. Geo. Holder, Glenwood, Ark.

AUTHORS SERVICE

NEW Writers Wanted to re-write ideas in papers, magazines, books. Splendid opportunity to break into profitable writing field. Rush postcard for Free Details. Comfort Writer's Service, 210-R, South Seventh, (2) St. Louis, Mo.

BEGINNER WRITERS—Ten Basic Lessons 50c. Anderson, Vineburg, California.

AUTOMOBILES

SAVE Gasoline and your Motor. Improved Octane Hyperlube, the Synchronistic Hyperlubric Motor Fortifying Super Fuel Energizer. Send One Dollar for 900 Miles of Octane Hyperlub Motor Maintenance. Agents wanted. Money Back Guarantee. Hyperlube Co., Box 46, Long Island City, New York.

AUTOMOBILE Racing Book. Fifth Edition Revised. Tells how to build dirt track bodies, frames, engines. Records, superchargers, rules, formulas, plans, stock conversions, roadster racing, fast Fords. $1.00 postpaid. $1.15 C.O.D. Ray Kims. Department 774, Madisonville, Cincinnati, Ohio.

WHIRLGAS Turbinator $3, brings remarkably efficient economic motor performance by cyclonic vaporization of carburetor mixture. Wrench installs 15 minutes. Give auto make, year. John Hartley, 5718 Lorraine, Detroit 8, Michigan.

RENEW car batteries inexpensively. Instructions $1.00. Popular Service, Racine, Wisconsin.

1943 IGNITION Supercharger, $3.50. Quick Starting. Mileage. Pep. EG Sales Mfg. Co., 60 John St., New York.

AUTO SUPPLIES & EQUIPMENT

CALIFORNIA Style Dual Mufflers V-8 Set. Saves Gasoline, Increases power. Black finish, beautiful deep tone, complete $20. —— Clymerlite Finest Aluminum pistons finished oversized or semi $2.50 each. — Clymer Spotlights $4.75. Motor Scooters. Catalog 10c. Clymer, Los Angeles 15, Calif.

DIESEL conversions for auto, tractor and Marine engines. Cheap installation. Wonderful performance. Proven factory method. Different and better. Costs nothing to investigate. Write for free circular No. 3. Harrington Company, 201-204 Manchester Bldg., Portland, Oregon.

1,000 MOTORISTS needed to make gas saving test. Up to 30% savings. For free test offer write Vacu-matic Carburetor Co., 7617-858 W. State St., Wauwatosa, Wis.

OPERATE cars, trucks, tractors, engines with wood or coal gas, ½ price of gasoline, extensively used in Europe, complete detailed information $1.00. P. M. Harris, Westby, Wisconsin.

AUTOMOBILE Fuel without gasoline. Guaranteed formula; send $1 today. United Research, Box 131, Orange, N. J.

USED parts (Guaranteed) All cars. Describe needs fully; immediate reply. Victory, 2439½, Gunnison, Chicago.

GASLESS Gas! Quickly, easily compounded. Formula, 25c. Dudley, B41, Covington, Ky.

ANTI Freeze, noncorrosive, inexpensive, manufacture yourself. Send 3c stamp. Beike, Box 699, Borger, Texas.

AVIATION

PROPELLERS—All types, sizes, including 3 blade special for sleds, boats. Ford conversion diagrams. Illustrated literature 25c. Standard Aerocraft, Ft. Worth, Texas

AIRPLANES $185 up. Motors, crackups, parts. Send 25c for latest War-Bargain Catalogue. Used Aircraft Directory, Athens, Ohio.

30 THRILLING Airplane Pictures—Army—Navy—large 8½ x 11 for framing $1.00 ... Set Free. Libman Co., Dept. B, Box 7833, Los Angeles

BUILD and fly your own motorcycle powered monoplane, home. Easy, cheap. Tested plans, guaranteed, $1.00. Aerotech, Dept ... Mich.

BATTERIES, GENERATORS, ETC.

EDISON Batteries. Power Light. Five year guarantees. Fifteen year life. Complete lighting equipment. Free literature. See-Jay Company, 321 Yonkers Avenue, Yonkers, New York

BOATS, OUTBOARD MOTORS, ETC.

FULL size cut to shape boat patterns, blueprints 7½ 38 feet. Illustrated "Build a Boat" catalog 10c (coin). How to Build Boats [illegible] $1.00. Cleveland Boat Blueprint Co., Station A-77, Cleveland, Ohio

MARINE Power. Easily convert any Ford motor (domestic and foreign) with Osco parts and kits. Complete catalogue 25c (coin). Osco Motors Corp. 3427-79 N Lawrence St. Philadelphia, Pa.

OUTBOARD Motors. Used and Rebuilts. Save money. Used parts. Bargain list free. Crandall-Hicks, 856 Commonwealth, Boston, Mass.

BODY-BUILDING COURSES

SUPER Ju Jitsu. Lightning defense and attack system. Sensational new home study course now ready. Learn to lick bruisers twice your size with only your bare hands. Free details. Nelson Co., 321 South Wabash, Dept. 2-500, Chicago

BAR-BELLS, Dumbbells. Exercise equipment, Courses, Special offers! Free booklet. Good Barbell Co., 3361-PS Watson Road, St. Louis 9, Mo.

DEADLY Judo Wrestling Boxing Stamp brings (free offer) details. Variety House, Box 56-C Station N, New York City.

BE strong, muscular, full of pep. Amazing new body building course. Write Olympic System, Waterville, Me.

BOOKS, PERIODICALS

BUSINESS- Vocational- Diversion Magazines. Current single copies. Choose from 800 different publications covering Air Conditioning, Aviation, Automotive, Beverage, Confectionery, Container, Electrical, Live Stock, Music, Photography, Plumbing, Printing, Radio, Refrigeration, Upholstering, Watchmaking and more than 150 other fields. List with prices free. Commercial Engraving Publishing Company, 348 North River, Indianapolis 1, Indiana.

MATHEMATICS Dictionary by Glenn James, University of California and R. C. James. Lasting, useful, attractive Christmas Gift for anyone studying or using Mathematics. Deluxe edition, 277 pp. $3.00. Two or more copies, $2.50, mailed as you direct. The Digest Press, Dept 3e, Van Nuys, California

UNCENSORED! Broadway! Night Clubs—Cabarets—Girlie Shows—Get the Most For Your Money. Dance Hall Sirens, Chorines! "New York Behind The Scenes" tells all. Send 50c. Palace Sales, 480-P Lexington Avenue, New York City.

EDUCATIONAL Books sold cheaply or rented for small fee. Books bought. Money back guarantee. 4,000 Bargains. Catalog Free (Courses Bought). Lee Mountain, Pisgah, Ala.

CHINESE Physicians. Secrets. 165 pages, rare illustrations, unpublished truth, secret healing arts, peculiar customs. $1. Write Garding Ltd. Box 6227 Metropolitan Station, Los Angeles California

ANY Book (New, Used, Out-of-print, Rare) promptly supplied. Lowest prices! Send for free bargain catalogue! Old Prof's Book Shop, 816 Arcadia Court, Pontiac, Michigan.

"LIGHTNING Over The Treasury Building" exposes the "Money Trust", cloth $1.00. Understand Money. Meador Publishing Co., 324 Newbury, Boston 15, Mass.

EXCELLENT Sparetime profits handling subscriptions. 2500 magazines. Confidential Catalogue. Starting Supplies Free! Prime Subscriptions, Flushing, N. Y.

BOOKS, (out-of-print, new, used) quickly supplied. Many 35c bargains. Catalogue. T. Jankowski, 10670 Mark Ave., Detroit, Michigan

TWENTY five cent booklets. Principles of Electricity. Physics Self Taught. "Geometry Self Taught". Tom Waltman, 3e4 Broadway, New York

5c BUYS back dated magazines. Foreign, domestic arts. Catalog 10c. Cicerone's Magazines, 863 First Ave., New York 17, N. Y.

INVISIBLE Glasses. (Contact Lenses) Replace eyeglasses. Information and descriptive booklet, 25c. Service Publishers, 1331 E. 5th, Chicago

BOOK Of Adam, completes Bible lineages. Price $1. Charlemagne chart 50c. Adam lineage 25c. Harold Bowen, Dept P. Osceola, Missouri

THRILLING Free Book Offer. Stamp brings details. Variety House, Box 56 B, Station N, New York City.

5 MOST read mail order magazines 25c. Armand Cartier, 6038 North, Pittsfield, Mass.

"PIN UPS" 100 Glamour Girl Subjects. Huge Bargain Pack $1.00. Clover Novelty, ... N. Y.

PHOTOGRAPHS! Novelties! Books! Samples, lists—50c. Nuart, 2041 East 21st, Oakland 6, Calif.

A RATIONAL View of Life. 40c. Benjamin Robert, Urbana, Ohio

ADULT Books. Catalog Sample 25c. Lafavor, Box 1... San Bernardino, Calif.

ADULT books. Sample and catalog, 10c. Alstone, 298 ..., ...burg, Mass.

BUSINESS OPPORTUNITIES

PLASTEX Industries offer industrious men an opportunity to start a business of their own manufacturing art goods, novelties and utility products in Plastex and marble imitation. The material makes regular 10c store seller. Rubber molds furnished for speed production. Small investment brings big returns. We are now placing big chain store orders with manufacturers. Ambitious men have chance for real prosperity. Plastex Industries, Dept. 8, 1085 Washington Ave., New York, N. Y.

HOMEWORKERS! Manufacture gifts, plaques, novelties; 90% profit, material, molds, instructions furnished. Sample large scottie mold model, door stop, savings bank, radio ornament, with illustrated molding circular, catalogue new flexible molds, $1.00 postpaid. Plastic Products, ... Belmont, Chicago

START Home Business making statuary, plaques, art goods, novelties, souvenirs, concrete pottery, garden furniture, artificial marble flooring, liquid marble. Make your own flexible molds. Amazing profits. Valuable folder free. Creative Publishers, P613, Glencoe, Illinois

COLOR Concrete with chemicals. Stucco-fork. Cement Artistry. Washing walls. Spin concrete pottery. Benches. Garden Ornaments. Cold glaze, concrete paint, marbling. Sample 10c. Hollywood Cement-Craft, 8530 Wonderland, Hollywood 46, Calif.

LIQUID Marble, snow white, multi-colored. Glazed. Cop... Composition Flooring. Lifetime wear. Any color. No priming. Flexible molds. Plaster casting. Get into the big money now. Full information given free. Write Compo-Tex, Box 780 P, St. Louis, Mo.

MECHANICALLY Inclined Men. Own and operate general Appliance Repair shop. Complete illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business, etc., all phases covered. Free literature. Christy Supply, Dept 734, 2835 N. Central Ave., Chicago

BRAND New Book. 48 pages, 40,000 words. 300 tested moneymakers, successful mailorder plans, business secrets, formulas, wholesale supply sources—25c moneyback guarantee. Smith Publications, 313a Comstock, Syracuse 10, N. Y.

LIQUID Marble. - Marvelous colorful! Brushed, sprayed, molded, Rubberlac molds! Composition Flooring! Particulars free. Marbelizing Service, Edwardsville, Ill.

WEBER Typewriter Mechanics School. Simplified homestudy. Repairing increasing. Canton 8, Ohio.

MAIL Order Business Course shows you how to make money, spare or full time. Teaches professional mail order technique—not penny-catching schemes. Free details. Nelson Company, 321 South Wabash, Dept 403, Chicago

LEARN Refrigeration Service. Open your own business. Small capital required. Easy work. Fine opportunity for older men. Easy illustrated home course. Low cost. Free Booklet. Mechanics School, Dept. S-21, 4701 West Pico, Los Angeles 6

GOOD Paying Business. Silvering mirrors, plating, ... reflectors, ... bathroom fixtures, etc., by late method. No tanks or shop required, outfit furnished. Free sample. Gunmetal Co., Ave. E., Decatur, Ill.

MY Plan Will Work For You. Send 10c (refundable if not satisfied) for information regarding this plan. Free premium included. George L. Nute, 171 Trenton St., E. Boston, Mass.

SELL Books, plans and lotion by mail. Large descriptive list with complete selling plan for one dime. E. Minnick Co., Timberville, Va.

BOOKS, check full of money making ideas, formulas, plans, information. Literature free. ... 3... Third Ave., Montgomery, West Virginia

FORTIFY The Future. Own Business. Home, office. Free particulars. 100 Money Making Plans. National Enterprises, ... Nashville 4, Tenn.

START Profitable collection business your community. Fine income assured. Convincing literature free. Morrison Business Service, Pontotoc, Miss.

SIGNS and showcards easily and expertly painted with Letter Patterns. Many sizes and styles. Write for descriptive folder. John Rahn, B1130 Central Ave., Chicago 51

CAPITAL Seekers—Interested in raising $25,000 or more for a legitimate project should write to Amster Leonard, Fox Theatre Bldg., Detroit 1, Michigan

300 EXPOSED secrets. Tricks. Magic. Rare formulas. Literature Free. Write Formaco Systems, 3... Kiefaber, Dayton, Ohio

PAINT Signs for Profit with aid of lettering patterns. Free literature. Sample alphabet 10c. Display Letters Co., Box 26, Fort Hamilton Sta., Brooklyn 9, New York

127 WAYS to make money, in home or office, business of your own. Full particulars free. Elite Co., 214 A, Grand St., New York

PLASTIC Engineering pays big. Home study course. Low cost. Easy terms. Free booklet. Ohio Institute of Technology, Box 120, Greenville, Ohio

HOW To Make Simple Molds and Plaster Plaques. Profit in popular novelties! Book 25c. Plastercraft, 1608 E. 43rd St., Cleveland 3, Ohio

BE independent, operate a pleasant, profitable business of your own. Rush 50c to O. Jepson, 132 "E" St., Salt Lake, Utah, for complete plan

BOOKKEEPERS—Earn $2.00-$3.00 hourly operating Simplified Tax bookkeeping System locally. Permanent. Write, Thrifty, Danville, Illinois

MAGIC Races—At Cigarette Touch six horses are off. Fast seller. Big profits. Six races and quantity prices, 25c coin. Greene, 4316B Redwood, Venice, Calif.

PERFUMERS make big money. I furnish complete detailed instructions. Don't delay, write Dr. Abeli, Parkway Bldg., Pasadena, Calif.

YOU! Yes, you can learn how to make mold and cast Real Plastics. Send stamped envelope. Box 491, Gainesville, Texas.

MAKE Money at home in spare time by mail. Write Gordon Publishers, Box 21, Pawtucket, R. I.

WINTER Is Coming! Make your own antifreeze. Nine formulas $1.00. Box 177, Gainesville, Texas

EXTRAORDINARY opportunities. literature, Big Mail, 10c. ...'s, 230 Bankers Investment Bldg., San Francisco, Calif.

READ Robert Collier's Home Mail Order Methods. Get 31 day trial offer. Dowpos, 1217 Park Row Bldg., N. Y.

MOLD-MAKING Plaster casting. Moneymaking Business. Literature Free. Kembly, Park Ridge, Illinois.

UNUSUAL Profitable Cooperative Plan, 25c. Nielsen, Box 217-B, Hicksville, N. Y.

SWISS Music Box Works—$1.00 to $2.25. Suitable for many novelties. Merrod Manufacturers 147 West 46 1 Street N Y

PAYING Mail Business—stamp brings proof. General Publications, Ossining 1, N. Y.

BUY, sell, by mail. Opportunity man 10c coin. Edward Macdonald, Box 136 B Seattle 11, Washington

250 PRESENT Day Opportunities. 75 pages 25c. Home Industries, 1318 S. 30 A Omaha Nebraska

START Local or Mail Order Business. Write Dune's, Delislow, W. Va.

BUSINESS SERVICE

LEARN How To Build A Mail Order Business of your own anywhere! Many great mail order successes were built from very small beginnings growing from reinvested profits. Now is a good time to sell by mail: more people employed, more surplus money available than ever before, people spending more time at home reading advertisements and mail literature. Our big 24 lesson illustrated course in Modern Mail Merchandising gives real fundamentals of the business; tells how to start, following proved plans and procedures. Mail order business booming as never before. Get our illustrated prospectus describing our practical course, see what this grand industry offers You. Write, Mail Enterprises, Inc., 332-A Chester-Twelfth Bldg., Cleveland, Ohio.

LOS ANGELES Calif., mail address. We receive, reforward business, personal mail. Write Coastal Service, 123 N San Pedro St., Los Angeles 12, Calif.

FINANCIAL Independence for Married People. Successful plan 50 cents. Harry D Cater, 444 Washington St., Denver 3, Colorado

REPRESENTATION In Washington, D. C. Write Service Bureau, 1401—35th St., S E.

CAMERAS, PHOTO SUPPLIES

WE Pay Top Prices for used cameras and photographic equipment. Turn your idle camera, enlarger, printer, lenses, developing equipment, etc. into cash. Just send us a list of what you have. Give make, model, age, condition. We will write you at once telling you what we'll pay. Prepare your list today. Send to Central Camera Co. (Photographic Headquarters since 1899), 230 S Wabash Ave., Dept. K 142, Chicago, Illinois

MOGULL is On a Buying Spree and Pays Top Cash For Photographic Cinematic Items. Cameras, Projectors, [illegible] Address Systems, Enlargers, Sound [illegible] Lenses, Accessories, Films, etc. Complete and partial units considered. Liberal appraisals, immediate cash. Bring or write frankly describing items in full detail. Mogull's, 60 West 48th St., New York 19, N. Y.

WE pay peak prices for cameras, lenses, movie cameras, movie projectors, movie lenses, binoculars. Sell now! Write giving full particulars, condition or send in via railway express collect for free estimate or C.O.D. with inspection privilege. If no purchase your property will be returned to you prepaid, insured. Aremac Camera Co., Dept. S, 1 E. 43rd St. New York 17, N. Y.

AMATEUR Photographers attention! Improve your hobby of picture taking and learn how to make money with it. Write today for our 40 page book catalog and a sample copy of American Photography enclosing ten cents for postage. Contains articles and pictures of the world's foremost writers and pictorialists. Camera House 141, 353 Newbury St., Boston, Mass.

BASS Says: War time proves Bass leadership. Amazing selection of fine still cameras—Leica, Contax, Korelle Reflex, Argus, new and used still available. Write for quotations. Satisfaction guaranteed or your money refunded. Bass buys 'em, sells 'em, trades 'em. Bass Camera Company, Dept. SP, 179 W. Madison St., Chicago, Ill.

OIL coloring photographs a fascinating hobby or profitable business. Learn at home. Easy simplified method. Previous experience unnecessary. Send for free information and requirements. National Art School, 1315 Michigan, Dept. 174C, Chicago

AT Last—Air and Light defying patented developers. Will not spoil when not in use. [illegible] soft working [illegible] contrast. Quart 50c. Graphic Economy Developer Co., 1624 S. Trumbull, Chicago 23, Illinois.

CASH. Spot cash for cameras, lenses, binoculars, home or theatre sound projectors. Send full description by mail or wire for prompt cash offer. Over 30 years of dependability assures honorable dealings. Bass Camera Company, 179 West Madison Street, Chicago, Illinois

MAKE money in photography. Learn quickly at home. Easy plan. Previous experience unnecessary. Common school education sufficient. Booklet and requirements free. American School of Photography 1315 Michigan, Dept. 174C, Chicago

CARTOONING, SIGN PAINTING, DRAWING AIDS

CARTOONING Course. 30 Lessons. 6 booklets. 414 illustrations. $2.00. Stamp for details. Home Cartooning Institutions, 2456 West 116th, Chicago.

CARTOON Course. Big, Guaranteed. Complete—$1.00. John Warren, N 1409 Smith, Spokane, Wash.

LAUGH producing program. $1.00. Illustrated catalog 10c. Cartoonist Balda, Oshkosh, Wis.

CARTOON course, Manual of plans, markets, Cartoon bulletin. Details. Hartman, 2436 W. Lincoln, Nebraska

CHEMICALS & APPARATUS

CHEMISTRY laboratory apparatus and chemicals for industrial, analytical and experimental laboratories. Complete supply service for students taking correspondence school chemistry courses. Send 3c postage for free 44 page catalog. Dept. M26, Biological Supply Co., 1176 Mt. Hope Ave., Rochester 7, N. Y.

WINN'S new idea Home Laboratory Chemical Kits and apparatus outfits for home experimenting. Send 3c for literature and [illegible] catalogue. J. H. Winn Co., Dept. [illegible] 24 W. 23rd St. N. Y.

HANDBOOK for Chemical Experimenters. Hundreds of experiments illustrated. 50c. Experiment booklet, 10c. Reading Scientific Company, Reading, Pa.

LABORATORY Supplies at Wholesale Prices. Chemistry, Biology, Physics. Catalogue 10c. National [illegible] Co. [illegible] W. North Ave., Chicago. Established 1908.

CHEMISTRY For Beginners" and "Chemistry Of Familiar Things"—both excellent books 50c. Ted Waltman, 300 Broadway, New York

CHEMICAL Consultation. Advanced opinions for small fee. War problem appraisals preferred. Consultant, 17 Mayfield, Metuchen, N. J.

GLASSWARE 40 pieces $2.00. 15 Chemicals $1.00. Catalog. Rankin, Glover Bldg., Kansas City, Mo.

LUMINOUS Paints will glow in dark. Six colors. Fairmount Chemical Co., 236 Liberty St., New York City 6

FREE Catalog. Chemistry, Mineralogy, Biology, Optics. Tracey Laboratories, Evanston, Illinois.

LABORATORY Spectroscope for chemical analysis $2.50. McCutting Sons, Campbell, California.

25 PIECE chemical set, experiment booklet only $1.00. Colonial Chemical, Brockton 38, Mass.

200 PAGE Apparatus Catalog sent for 50c. 132 Page Chemical Catalog 25c. Laboratory Materials, 7317 Vincennes, Chicago.

FREE chemical catalogue. Enclose 3c Postage. Greenwood, 390 Broadway, N. Y.

DETECTIVES

DETECTIVE training-Secret investigations-Easy method-Fingerprints. Booklet Free. International Detective System, 1701 Monroe N.E., Washington 18, D. C.

DETECTIVES make big money. New method. National Detective, 309 E. Lafayette, Tampa 2, Florida

DETECTIVE Training. Phillips Secret Service. 1917-C North Kenneth, Chicago, Illinois.

DETECTIVES—Work home—Travel. Experience unnecessary. Write, Wagoner P-125 West 86th, N. Y., N. Y.

FINGERPRINT, detective instruction. Particulars free. Mushak, 4127-B Westminster, St. Louis, Missouri.

DOGS, BIRDS, PETS

STOP Running Fits. Money back guaranteed remedy $1.00. Circulars sent free. Edison A-10 Denmark, South Carolina

RABBITS. Flemish Giants, New Zealands. Reasonably priced. Franklin Young, Riverhead, Long Island, New York

WILD geese, ducks, fancy pigeons, peafowl, rabbits. Prices free. Jewel Game Farm, Danville, Illinois

WANTED—White Pigeons. Express paid. Cramore, 2753 Monticello, Chicago 18.

RABBITS, Mice, Pigs. Catalogue List 10c. Houck Company, Tiffin, Ohio.

DRAFTING INSTRUMENTS

ELLIPSES or ovals easily described with the Paragon Ellipsograph. $3.75. John Nation, Clement Ave., West Roxbury, Mass.

FREE catalog of drafting instruments and supplies. Gordon's, 162 D. Madison, Chicago

DRAWING & ART SUPPLIES

ART Kits Oil Painting Set. 12 Tubes Oil Color 1/2x4 inches, turpentine, linseed oil, brushes, palette and canvas board $2.00. Edward's, 818 66th Ave., Phila., Pa.

EDUCATIONAL & INSTRUCTION

PREPARE yourself now for a well paying radio position after the war. Obtain your FCC commercial radiotelephone and telegraph licenses through our home study courses, written for the man who has forgotten higher mathematics. An easy read, easily understood course. Moderate tuition fee. Write for particulars. American Radio Institute, 44 East 23rd Street, New York, N. Y.

EARN Certified Grapho-Analyst degree analyzing handwriting. Students report earnings up to $1.00 an hour spare time, $[illegible] weekly full time. Graduates in employment, credit agencies, police departments, courts, business and in private practice as Personal Problem and Vocational Advisors. Fully illustrated Grapho-Analyst and 3000 word illustrated lesson free. Institute Box 1160, Joplin, Mo.

WELDING—Electric Arc. Learn quickly by actual practice at Hobart Welding School. Individual instruction at bare cost of materials used. 50c in stamps brings valuable welding lessons postpaid and full particulars. Hobart Welding School, Box P-1132, Troy, Ohio.

PSYCHOLOGY teaches about mind. Bio-Psychology teaches about powers of mind over body. Use powers subconscious mind. Grow. Broaden education. Develop personality. Control emotions. Succeed. Correspondence. Dept. P. Taylor School of Bio-Psychology, Chattanooga 1, Tenn.

PREPARE Now for the avalanche of America's Post-War Billions in business enterprises. Get set to secure your share. Study business under guidance. Study money. Particulars Free. Educational Books, 237 N. Rutan, Wichita, Kansas

GOOD "Used" educational books on all subjects bought, sold, rented, exchanged. Satisfaction guaranteed. Complete details and 84 page illustrated bargain catalog Free. Write Nelson Company, 321 South Wabash, Dept. 203, Chicago

CLINICAL Laboratory Technicians in great demand. We train you in your spare time, in your own home. You can practice while studying. Write for free catalogue. Imperial Technical Institute, Box 973-E, Austin 5, Texas

RADIO Engineering, Broadcasting, Servicing, Electronics, Aviation, Marine & Police Radio taught thoroughly. All expenses low. Co-educational. Catalog free. Dodge Institute, Dept. 600, Valparaiso, Ind.

MAKE up to $25-$35 week as a Trained Practical Nurse! Learn quickly at home. Booklet free. Chicago School of Nursing, Dept. M-11, Chicago

PLASTIC Engineering pays. Home study course. Low cost. Easy terms. Free booklet. Ohio Institute of Technology, Box P-120, Greenville, Ohio.

REFRIGERATION Service Course. 24 illustrated manuals. Easy, quick, low cost. Free booklet. Mechanics School, Dept. S-22, 4701 West Pico, Los Angeles 6

USED Correspondence Courses and Technical Books Bought, Sold, Rented. Catalog Free. Educational Exchange, Henager, Alabama

PROPHECY Club reveals FOR name approximated by six prophets who described new Christ. Christ is here. Details dime. Nichols, Box 85, Waltham, Mass.

EXCEPTIONAL Opportunity. Operate a Collection Agency Credit Bureau. Quickly learned. Many make $5,000 yearly up. Write Cole Associates, Syracuse, N. Y.

FREE list, world's best technical books for home training, Metro, 711-S, So. Dearborn, Chicago 5.

CODE Language. Conversation immediately. Invaluable. Instruction Booklet 25c. Zend, Burbank, California.

TECHNICAL Books, Manuals Reference. Defense Training. Many subjects. Free List. Signs Farmington Missouri.

PROFITS without merchandise! [illegible] word course $2.00 postpaid. Challenge Association C-D Cincinnati.

HOME Study course, drugless therapy. Free literature. Institute of Drugless Therapy Tama Iowa.

SUPERIOR typewriting course touch system complete $1.00 Superior 2842 Arlington St Louis Mo.

LOCKSMITH Course. Lock picking key-fitting etc $1.00 prepaid. Muller's Key Shop Canadian Texas

BE Successful! Learn drafting now. Monroe Institute PS 1 Akron Illinois.

ELECTRICAL SUPPLIES & EQUIP.

FOR Motors, Welders, Generators, Other Electrical Items, Write LeJay Mfg., 823 LeJay Building, Minneapolis, Minn.

ELECTRIC Pencil: Writes—Engraves all Metals. $1.00 postpaid. Beyer Mfg 4515 C Cottage Grove, Chicago 15

WIND Electric Motors Yourself. Write Simplex, Box 280A, Pontiac, Mich.

EMPLOYMENT SERVICE

EXECUTIVE Office Workers, foremen salesmen and others. This is a good time to secure better, bigger positions, larger salaries. If you desire greater security and financial advancement, now is the time to make a change for the better. Let me tell you how to get the position you really want. Send name and address for free information. Employment Counselors Sedalia Missouri

ENGINES, MOTORS, ETC

BRIGGS & Stratton 1 H P Engine. Suitable for scooter, mower, etc $18.00 Rankin, 203-A South 77th Street, Milwaukee 13, Wisconsin

WINDING Data 225 motors single and three phase $1.00 Motor Data Box 763, Kansas City 1 Mo

FARM MACHINERY

BUILD Powerful Farm Tractor from old auto parts. Plans, instructions, $1.00. Money back guarantee. Science and Mechanics Magazine, 727 St. Clair Bldg. Chicago

FARMS, OTHER REAL ESTATE

SEE the Highlands of Louisiana where winter brings no idle acres. Choice cut-over land at low prices with terms. Send for descriptive book without obligation. Long-Bell Farm Land Corporation, 807 R. A. Long Bldg., Kansas City, Mo.

STROUT'S Big Farm Catalog! 68 Pages describing hundreds of properties in 18 states from Maine to Florida and west to the Mississippi—many pictures, rock-bottom prices. Write today for this money-saving time-saving book, Free. Strout Realty 255 ZB 4th Ave New York 10 N Y

GOOD Farm Bargains. Washington, Minnesota, Montana, Idaho, Oregon, North Dakota. Dependable crops, favorable climate. Write for Literature, lists describing typical farms. Specify which state. J. W. Haw 120 Northern Pacific Ry., St. Paul, Minn.

ORLANDO, Florida 5 acres on paved highway. Good fruit and vegetable land, easy terms; free booklet. Dept. Y Interstate Development Co., Orlando, Florida.

40 ACRES, near White River, unimproved poultry land, $190; $5 down, $5 monthly. Free list and literature. Hubbard, 289 Grossman Bldg., Kansas City Kans.

40 ACRES good land, $200, $5.00 down, $5.00 monthly. R. W. Stewart, Inverness, Florida.

FIELD GLASSES, TELESCOPES, ETC

MICROSCOPES, Telescopes, Binoculars, and scientific chemical laboratory apparatus bought exchanged. Exclusively our business for fifteen years. Not get-rich-quick speculators. Trial will show that we know apparatus. Highest prices paid. Harry Ross 64 W Broadway N Y

POWERFUL Telescope Lens Kit. Consists 1" diameter 75" focus objective. 50X and 100X astronomical eyepieces. While they last $1.35 postpaid. With 50X terrestrial eyepiece $2.95. PS-12, Pfleegor Optical Co. Sunbury, Pa.

ASTRONOMICAL Telescopes, binoculars, cameras, microscopes bought, sold, repaired. Send 10c for list of instruments desired. Rasmussen Box 294, Amsterdam, N Y

MICROSCOPES Research, Industrial, Amateur. Accessories. We sell, buy, repair, exchange. Inquiries invited. National Microscope Exchange, 110 Chambers St New York N Y

MICROSCOPES Scientific Laboratory Equipment bought, sold, repaired, exchanged. Catalog 10c. George Kuhn, 325 Fifth Avenue New York

FOR INVENTORS

INVENTORS Learn now—without obligation—how to protect and sell your invention. Secure Free "Record of Invention" form for establishing date of your invention, and Free Book "Patent Guide for the Inventor" containing complete information about patent procedure and selling inventions, illustrating over 150 basic mechanical movements. Delay may be costly. For prompt, confidential service—write—Clarence A. O'Brien & Harvey Jacobson Registered Patent Attorneys 32A M Adams Building Washington D C

INVENTORS Patent your invention. Send now for our new Free copyrighted booklet "Protect, Finance and Sell Your Invention" and "Invention Record" form. This booklet guides the inventor from the first step toward patent protection to final profit making from his invention. Reasonable fees, conscientious counsel. McMorrow & Berman Registered Patent Attorneys 143 Y Albee Building Washington D C

PATENT Your Idea. Write immediately for two free illustrated books "Patent Protection" and "When and How to Sell an Invention." 48 pages of valuable information for inventors. No obligation. Address Victor J. Evans & Co 742 P Merlin Bldg Washington D C

CAPITALIZE inventions without patent expense. Patents guarantee no protection. Send $1.00 for booklet "The Patent Racket" and profit thereby. R. V. Co., Box 142, Easthampton, Mass.

INVENTORS: New military and commercial inventions urgently needed by manufacturers. Write for particulars. Chartered Institute, Dept. 3-A. Washington D C

INVENTIONS developed. Drawings made. Models built. Machinery designed. Mfg. done. Good work. Fair prices. Davidson 634 C St San Diego Calif

INVENTIONS Developed, patented, financed, commercialized. Allied Patent Enterprises, P. O. Box 5701 Los Angeles 55 Calif

HAVE you a Patent? Will manufacture on shares. Campbell, 273 Mt Vernon, Detroit, Michigan.

CASH for practical ideas and inventions. Mr Ball, BB 9441 Pleasant Chicago

FORMULAS, PLANS, ETC

AUTHENTIC Formulary 926 pages (Illustrated) 10,000 Money making formulas, recipes, instructions, substitutes $2.00 postpaid or C O D. (Foreign, $2.35) Catalog. Adams Brown Chestnut Hill Mass

FORMULAS—Latest, best, Analysis. Literature free. E. Belfort, Engineering Bldg., Chicago 6.

FORMULAS—All kinds. Latest money-makers; literature Free. KemiKal, Park Ridge, Ill.

COAL Saver; Artificial Coal. Both Formulas 25c. R. Plumb, Herkimer, N Y

CHEMICAL Garden. Send Dime. Edwards, 324 North 18th, Quincy, Illinois.

GAMES & ENTERTAINMENT

READY—Big New Denison Digest Lists describes hundreds of Plays, Operettas, Musical comedies, complete Minstrel First Parts with song programs, blackface skits, vaudeville acts, monologs, dialogs, clever recitations, juvenile plays-songs, musical readings, books on games, entertainments for all occasions and ages. Denison's new 68th annual Digest explains each Play's plot, number of characters, playing time required. A valuable Entertainment Guide Book for families, schools, dramatic clubs, lodges, churches—all organizations. Individuals—be popular—learn clever recitations—see this Digest. Strictly limited edition—send only 10c (covering postage-handling) for yours now! T. S. Denison & Company (Established 1876) 225 North Wabash Dept 10 C93 Chicago 1

HAIR PREPARATIONS

USED by thousands of men for years. Pro-Ker, a common sense hair-scalp preparation for Hair Care. Loose Dandruff. Scalp Itch. Natural Hair Groom. Not greasy, does not stain. Clean fresh odor. No alcohol. Pre War Formula. Developed by Charles Nessler noted hair authority and author of "Our Vanishing Hair." Over 1,000,000 bottles sold. Money back guarantee. Big 16 oz. bottle $1.50 postpaid or C O D. Hair Products, 402 Madison Ave., New York City 17

HEARING AIDS & REPAIRS

HEARING Aids, Repairs, and Batteries. Quick Service, Wholesale, retail guaranteed. Marshall Brown, 10 East Congress Street, Chicago, Illinois.

HIGHGRADE SALESMEN

ADVERTISING Book Matches — World's largest "Direct Selling" Book Match Factory offers advance cash earnings calling on every type of business. Men or women. Experience unnecessary. Full, part time. Low Prices. High Quality. Quick Deliveries. Powerful Patriotic Display. Special Designs for Army Camps and Naval Stations. Repeats. Free Kit. Instructions, Match Corp. of America 3433 West 48th Pl. Dept N 12 Chicago 32

ADVERTISING Book Matches. America's largest manufacturer of Union Label Book Matches. Fast selling line. Large sales producing kit. Sample matches. Complete cut catalog, 17 color combination makes selling easy. Commission in advance. Superior Match Company 7530 Greenwood Ave Dept P 12 Chicago

SAMPLE Ten Dealers, Sell 1,000 wallets $40.00 profit. 1,000 potentials, bonuses. Ten self marker pocket wallets 25c (coin). Walsides. South Branch, Oak Park, Ill.

HOBBIES, COLLECTIONS

UNUSED Match Book Covers, 100 all different $1.00. 30 Royal Flash Covers $1.00. Free list. Charles Edelman, 1311P East 94 Cleveland 3 Ohio

GENUINE Arizona Ruby and Desert Sapphire. Send Quarter for both. Mineral Specimens Company, Box 2451, Phoenix, Arizona

HOBBY catalogue 5c, stamp—coin list 3c, framed Mexican feather picture $1.00, chameleon 25c. Quivira Specialties, Winfield, Kansas.

COLLECTORS! Add old Mexican money to your collection! Order our Special assortment today. Only 25c. Manise Photo Co. Colorado City, Texas

BEAUTIFUL Stones removed from rings, etc. 100 assorted $2.00. Lowe's, Box M 311 St Louis Mo

WANTED Automobile radiator name plates of old cars. H. Stockwell, Hutchinson, Kansas

24 BEAUTIFUL inch size ore specimens postpaid $1.00. Arizona Mineral Specimen Co. Cherry Arizona

I'LL show you how to make your hobby pay big money. Exciting details free. Pioneer Box 233PS, Bolton Landing N Y

WANTED: Old cigarette cards. Write Charles Bray, East Bangor, Pa.

HOME CRAFTSMEN

SQUAREKNOTTERS! Make belts, hand bags etc. Quality cord samples with catalog free; beginner's book, catalog and samples 10c. Special! Regular $1 book with 50c beginner's outfit, all for $1. P. C. Herwig Co., Dept. P-47, 121 Sands St., Brooklyn, N. Y.

20 LAWN Ornament patterns 25c. Other patterns 15"-22" high. Dutch girl, Dutch boy, pirate, bull terrier, Mexican girl, Mexican boy, dwarf, penguin, flower girl, 10c each, 3 for 25c. 25 novelty patterns 30c. All 62 full size patterns $1.00 postpaid. Strother, Box 143 EZ, Bellingham, W. Va.

PLASTER Enthusiasts Hobbyists! Here's new moulding compound! Nearest thing to Rubber Molds. Roni-Rub'r" moulding compound guaranteed by Roni Studios, Inc. Whitestone, New York City. 2 and 5 lb. bars, $1.50 per lb., postpaid.

CATALOG! Tools, Decal Transfers, Patterns, Novelty Furniture, Lawn Ornaments, Silhouettes, Letters & Numerals. Other Lines. 500 articles fully illustrated. Write W. Met Shop, Ashburn, Georgia.

270 ANTIQUE Firearms, Swords, Cartridges, Rifles, Indian Relics. Catalog 10c. (Photographs of Most) Heiks, Wenona, Ill.

NOVELTY Patterns, Lawn Ornaments, Corner Shelves 20c, Box 623, Chisholm, Minn.

MAKE Toys for gifts or profit. 12 original plans—complete instructions 25c. K. Stultz, 146 William St., Alexandria, Va.

BUILD Streamlined plywood kitchen cabinets. Plans 25c. Roger Underwood, 4617 Johnson Avenue, Western Springs, Illinois.

NOVELTIES from scrap wood, 25 patterns 25c. Patterns, kits; lists 5c. Lynde, Medway, Mass.

HOTEL TRAINING

GOOD Jobs for you in hotel and institutional field wartime housing, food and recreation projects. Thousands of men and women, all ages, needed for well-paid positions that offer color, excitement ever new and fascinating duties. Already built or under construction are over 3 billion dollars worth of government social and recreational buildings, officers' clubs, etc. Record-breaking business in hotels, clubs, institutions means even greater opportunities. Lewis school receiving calls for managers, business executive housekeepers, purchasing agents, stewards, housing supervisors, cafeteria directors, etc. Previous experience proved unnecessary! No need to leave your job to qualify. A good grade school education, plus Lewis Training qualifies you at home, in spare time. Our National Placement Bureau helps to place you, and under our amazing Certified Job Plan, actually guarantees you will "make good" when placed. Write today for free book. Lewis Hotel Training School, Room PZ-2765, Washington 7, D. C. (First and only school of its kind—Now in its 28th year.)

HUNTING

FREE! Fall "Guaranteed Bargain Catalog", featuring thousands guns and "Hard-to-get" items, send 25c (refunded with first order). Trade guns and ammunition, or Get Cash. (Name your own price.) We pay More, sell for Less, because we handle thousands upon thousands of new and used guns from $5 to $1000.00. All models, gauges, calibers, makes. We also buy, sell or trade Ammunition, Reels, Rods, Outboards, Binoculars, Cameras, Watches. Write, describing what you have to trade, or sell for cash! Money Back Guarantee, backed by 58 years fair dealing. Klein's Sporting Goods, Milton Klein, 5433 South Halsted, Chicago.

INFORMATION

ALASKA! The Land of opportunity. Are you planning to come to Alaska to enjoy this Switzerland of America? I will personally answer ten questions pertaining to Alaska for one dollar. Dr. Krowse, Member Chamber of Commerce, Juneau, Alaska.

INFORMATION—How to locate most any article made in the United States (Dime Coin). Rakes Specialty Service, P 2363 West 35th St., Chicago 9, Illinois.

INVENTIONS WANTED

NEW Product Ideas—A reputable manufacturer will consider new patentable items (preferably of metal) for manufacture and distribution in the aircraft, automotive, marine, industrial, or household field. Ideas will be purchased outright or on royalty if accepted. Write briefly the nature and intent of your idea and if interesting, we will send complete instructions on how to submit full details for fair consideration. Address P. O. Box No. 6796, Philadelphia, Pa.

INVENTORS. Have you a sound, practical invention for sale, patented or unpatented? If so, write Chartered Institute of American Inventors, Dept. 3-C, Washington, D. C.

INVENTORS. Patented or unpatented we promote your invention. M. Humphries, 413 Ouray Bldg., Phila., Pa.

CASH for Inventions—Patented, unpatented. Mr. Ball, BC-9441 Pleasant, Chicago.

INVENTIONS Promoted. Patented or unpatented. Write Adam Fisher Company, 183-A Enright, St. Louis, Mo.

INVENTORS! Have you good patentable ideas? Write Mr. Metzler, 11 West 42nd, N. Y.

JEWELRY

GENUINE diamonds, out-of-pawn low prices, wonderful values. Unredeemed loans and big buying power enables us to offer beautiful gems at prices far less than original cost. Shipped free for inspection, Appraisal. Send for Big Free list showing fine diamonds at startling low prices. Lloyd J. Butler, President, Prudential Loan Association, 133-GM North Clark St., Chicago 2.

LEGAL DIRECTORY

MEXICAN Legal Matters reliably handled. A. Munoz, 240, Juarez, Mexico.

MACHINERY, TOOLS & SUPPLIES

LEWIS Castings, Materials and Blueprints for Shapers, Mills and other shop tools save up to 5/6th the cost of comparable finished units. Handle many war jobs efficiently and economically. Plain or semi-finished castings can be furnished. Send 10c to cover cost of mailing Catalog describing 23 items. Lewis Machine Tool Co., Box 118, Station A, 834, Los Angeles 31, California.

INDEX Heads for sale. Very inexpensive. Sixty-two different divisions. Used on small lathes, drill press, milling machines, etc. Make gears, hobbs, cutters, etc. Very accurate and durable. Not a toy. Used by defense schools and hobbyists. Write for free folder. Long's Index Heads, 2127 East 7 St., Torrington, Wyo.

BUILD your tractor from second hand automobiles! Convert your horse drawn farm equipment into tractor drawn equipment. Nolan's Garage, East Wareham, Mass.

FOR sale new and used reamer and milling cutters not catalogued. Furnish your list of requirements for prices. Write P. O. Box 493, Flint, Mich.

STEEL beam trammels for draftsmen, engineers, mechanics. Circular Free. Clair Company, Box 92, Blythebourne Station, Brooklyn, N. Y.

NEW caliper, direct reading, speeds up defense work, cheap. Free illustrated circular. Factory 811-H East 31st, Kansas City, Mo.

WAR Workers! Protect tools! Engrave name on tools. No electricity! 25c. Nye, 1902 Twelfth, Seattle, Washington.

ATTACHMENT grinds, drills, factory accuracy, $5.95 postpaid. E. E. Mfg. Co., 227 No. California, Burbank, California.

GRIND Drills Like Factory. Attachment for Bench Grinder. Cheap. Factory 811-A East 31, Kansas City, Mo.

RECLAIM dull and broken drills with Nu-Way Drill Grinder. Circular free. Tractor-Lite-Mfg. Co., Spirit Lake, Iowa.

MAGIC TRICKS, PUZZLES, JOKER NOVELTIES

FOOL Your Friends! Send 10c for 2 Postcard Views of Detroit, write your message, address, stamp and return to me. I'll mail them from here—Free. Arthur Drewry, 8303 Baldwin Ave., Detroit 13, Michigan.

1943 EDITION Douglas famous Catalog of 500 Tricks you can do! All the latest with cards, coins, thimbles, balls, ropes, apparatus, books, illusions. 176 pages, only 10c. Douglas Magicland, Dallas, Texas.

HOLLYWOOD Special Magicians button, catalog, ghost illusion and free trick for 25c. Magic House of Charles, Box 1682, Hollywood, Calif.

WORLD'S largest professional magic shop keeps you in touch with latest tricks. To receive mailings send 25c for 1943 catalog. Holdens, P-220 W. 42nd St., New York.

MAGICIANS', Gamblers' secrets exposed. Cards, Dice, Punchboards, Slot Machine. Catalog 10c. Book Co., Box 671, St. Louis 1, Mo.

HYPNOTIZE Anyone Quickly! Guaranteed Course $5.00. (Information-stamp.) Box 1373, Raleigh, N. C.

JOIN Magicians' Fraternity! Monthly magazine of tricks, sample 10c. International Magicians, Mount Morris, Ill.

HYPNOTIZE Anyone Quickly! Sure Fire Method $2.00. Mystic Sales, 7126 Puritan, Detroit, Michigan.

DOLLAR'S Worth Professional Magic Free with Illustrated Catalog 25c. 4463-PS Germantown, Philadelphia.

BE a Magician. Large professional magic catalog of latest tricks, 25c. Ireland, P-109 North Dearborn, Chicago.

LEARN Professional Magic in ten easy lessons. Success guaranteed. $1.00. Diablo, 5344 Foster Ave., Worthington, Ohio.

YOUR name screaming headlines, Hollywood newspaper 25c. Lelavor, Arrowhead Springs, San Bernardino, Calif.

500 MAGIC Books, Tricks and Secrets in stock. New lists Free. Magic Store, Minneapolis, Minn.

MANUFACTURING

MODELS, small lot manufacturing, metals, plastics, etc. Milburn, Burlington, Kentucky.

MILITARY INSIGNIA

FOREIGN Emblems, sample, price list, send 15c. Hobbyguild, 35-A West 32nd., N. Y.

SILK Embroidered Service Emblems, sample and price list 10c. Insignia Guide, 10c. Hobbyguild, 35-A West 32nd, N. Y.

MILK GOATS

DAIRY Goat Journal, Dept. 348, Columbia, Mo. Monthly magazine crammed with helpful information. $1 yearly, introductory 5-month subscription, 25c.

MISCELLANEOUS

A THOUSAND Laughs. Unique Jackass Cigarette Dispenser. Holds 10 cigarettes. Simply press donkey's head down, tail lifts—presto out slips cigarette. Satisfaction guaranteed. Shipped C.O.D. for 98c plus small money order fee or $1.00 with order. Sanimo Industries, Dept. PS-5, Spencer, Ind.

GREAT Fun. Letters mailed for you, N. Y., Chicago, Miami, Montreal, 10c. Receiving—Forwarding Service. Souvenirs, View Cards. Information 10c. Agents proposition 25c. Haller, 436 N. Y. Ave., Brooklyn 25, N. Y.

MEDICAL Laboratory Technicians in great demand. We train you in your spare time, in your own home. You can practice while studying. Write for free catalogue. Imperial Technical Institute, Box 973-E, Austin 3, Texas.

UNPAINTED Wall Plaques. 30 Different $1.00, 100 Assorted $3.00. Request Literature. Oman, 842 Broadway, St. Paul, Minnesota.

RECEIVE many magazines, samples. Your name in numerous mailing lists 10c. Howard, 396 Broadway, New York.

FREE Information. Amazing pamphlet, new easy way to success. Victor, 675 Eliot, Denver 4, Colorado.

DESCRIPTIVE Photo, 100 Addresses 25c. Hobby Humor 10c. Morrisis, 136-Rob, Main, Chicago.

FREE literature how to locate buried treasure and minerals. Fisher Laboratory, Palo Alto, Calif.

HEATING six rooms $20 yearly. Circulars 10c. Rosemberg, RR10 H, Cincinnati.

UNUSUAL Novelties, samples 10c. Modern, Box 2, Station H, New York 2.

MODELS & MODEL SUPPLIES

SHIP model kits and fittings. Complete line Fisher model yacht equipment. All Boucher, Fisher Marine Model and Ideal Kits, fittings and blueprints at standard prices. Most complete stock in New England. James Bliss & Co., Inc., 220 State St., Boston, Mass.

MOST complete Illustrated Catalog—"O-HO OO" Model Rail and Parts ever published. Send 5c for mailing. Selly, 1377 Gates Ave., Dept. 3-2, Brooklyn, N. Y.

RAILWAY models, complete line informative catalogs, O Gauge 104 pages, 25c, HO 48 pages, 15c. Walthers, 300 Erie, Milwaukee, Wisconsin.

PLANES, Boats, Hundreds of Hobby Items. Catalog 3c. American Hobby Center, Dept. S-123, 40 E. 21st., New York 10, N. Y.

CATALOG 50 engines, model railroad supplies, 25c, refunded. Howardon, P-2417 North Ashland, Chicago.

SHIP Model and yacht supplies, complete large 64 page Catalogue. 20c. Wm. Wild, 510 E. 11th St., New York City.

MONEY MAKING OPPORTUNITIES

MECHANICALLY Inclined Men—Own and operate general Appliance Repair shop. Complete illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business, etc. all phases covered. Free Literature. Christy Supply, Dept. 1434, 2835 N. Central Ave., Chicago.

MAKE money at home in sparetime. Mail-order business is your opportunity. Start with as little as $2.00. New amazing system that works wonders, prepared by expert. Startling information free. Alfred Siddell, Atascadero, Calif.

LEARN Metascience. Remarkable drugless healing. No massage. No apparatus. Unbelievable simplicity and results. Inexpensive correspondence course. Write Metascience, De Land, Florida.

START A Home Business In Spare Time—Make extra money. Experience not essential. Literature, stamp. Goffiot Service, Alhambra, Calif.

DIMES! Quarters! Dollars! By mail. Latest Plan. Your name listed permanently with over 100 firms—10c. Novel Enterprises, Box 457, Reno 3, Nevada.

DETECTIVES Earn Big Money. Experience unnecessary. Particulars free. Wagoner, P-125 West 86th, N. Y., N. Y.

OPPORTUNITIES Galore, plan mails 10c. Sample mailing free. Harvey Teeple, (PS) Decatur, Ind.

BE your own boss. Operate a magazine subscription business at home. American Readers Service, Hatfield, Pa.

EARN money evenings, copying and duplicating comic cartoons for advertisers. Comic-Ads, Argyle, Wisconsin.

TRADERS' Club members earn big money because??? Anderson, Vineburg, Calif.

MONUMENTS

MONUMENTS—Direct Low Prices. Freight paid. Guaranteed. Free Catalog and samples. Write Granite-Marble Factory, A49, Oneco, Florida.

MOTION PICTURE & SOUND EQUIPMENT

8-16mm FILM-SUBJECTS — Black and White and Color, Sound or Silent. Largest selection ever compiled, 75c to $.00. Write for new, Deluxe 1943 Catalog—profusely illustrated! 25c (coin) refunded first purchase. Hollywood Movie Supply, Hollywood, California.

MOVIE Camera Outdoor Film, 100 ft. roll 16mm $2.50; 25 ft. roll Double 8 $1.25. Free Developing. Sell Finished Subjects. Catalog. Better Films, 742 New Lots, Brooklyn 7, N. Y.

GUARANTEED Fresh 8mm film. Three spools Double 8mm $1.65. Six spools Univex Roll B $2.65. We ship C.O.D. Fao Film, 3045 Central, Kansas City 2, Missouri.

100 16 MM. Used sound film, $1.00 postpaid. Write for list of complete subjects. Blackhawk Films, Dept. P56, Davenport, Iowa.

SIXTEEN Beautiful glamour girl subjects. Our latest. Lovelies. 8mm 50 ft. $2.00. 16mm 100 ft., $4.00. Lists, sample, dime. Jenkins, 392-A, Elmira, N. Y.

"THE World's Greatest Passion Play" in 8mm, 16 and 35 mm. Specify Sound or Silent. Rent or Purchase. Hemenway Film Co., 31-Z Melrose St., Boston 11, Mass.

"ALL-AROUND" Reflector Co. guarantees their reflector will give 25% more screen illumination on Revere Projectors. Address, 0 .1 Euclid, Cleveland, Ohio.

MOVIE Film 100' 16mm $1.90—25' double 8mm $1.25 developing included. Ambassador, 479-A Quincy Street, Brooklyn.

35MM SOUND features! Shorts! Technicolor samples 10c. Dewsey, 1613 Stewart, Youngstown, Ohio.

8-16, FILM subjects. $1.55 up. List, stamp. Pence Service, 2484 Liddesdale, Detroit, Mich.

WORLD War No. 1 300ft. 8mm $6.50. Cope, 3720 South Figueroa, Los Angeles 7, Calif.

LEARN Movie Projection, Management. Free catalog. Give age. Theatre School, Elmira, N. Y.

SALE, rent, exchange, 8-16mm movies. Send stamp for catalogue. Bailey Films, 1652 Cosmo, Hollywood 28, California.

HOME Movies you'll like 8-16mm Sample, lists 10c. Also 8-16mm Camera Film. Marshall, 413-P, Elmira, N. Y.

GLAMOUR Films! Lists, Samples, 10c. Superior, 136 Fourth, Paterson, N. J.

FREE Movie Film Catalog; sample 10c. Goodwill Company, Jackson, Tennessee.

SEND stamp for 16mm, 8mm catalogue. Sterling's, 679 Northampton, Easton, Pa.

MOTORCYCLES, BICYCLES & SUPPLIES

MOTORCYCLE Manual—192 Page American Questions-Answers complete servicing information Harleys, Indians, Hendersons, Servicycles, Villiers including war models $1.10 — Motorcyclist's Workshop $1.50 —— Two Stroke Motorcycles $1.50 —— Modern Motorcycle Mechanics and Speed Tuning, 435 pages rare American English Motorcycles $2.50, with drawings, specifications U. S. Army Jeep, German War Motorcycles $1.00. All postpaid. Clymer, 307 W. Pico, Los Angeles 15, Calif.

PLANS, Drawings, specifications, instructions for building attractive Motor-Scooter complete $2.00. Plans, instructions, E-Z to make your bicycle electrically driven $1.50. Scooter Catalogs 10c. Clymer, 307 W. Pico, Los Angeles 15, Calif.

100 MILES Gallon! Motor Scooters, Motorcycles, Whizzer Bicycle Engines, Midget Automobiles, Gasoline Engines. No priority Necessary. Full information, prices, illustrated catalog one dime. Clymer, 307 W. Pico, Los Angeles 15, Calif.

"MODERN Motorcycle Mechanics And Speed Tuning", 435 pages, 200 illustrations, the most up-to-date and complete book on motorcycles ever issued. $2.50 postpaid. Descriptive folder free. Nicholson Brothers, Saskatoon, Canada.

BEAUTIFUL Recap Motor-Scooter Tires. Information catalog 10c. Clymer, 307 W. Pico, Los Angeles 15, Calif.

MUSIC, MUSICAL INSTRUMENTS

PIANISTS Free booklet shows how you may greatly improve Technic, Accuracy, Memorizing, Sightreading and Playing through Mental-Muscular Coordination. Quick results. No obligation. Broadwell Studios, Dept. 91L, Covina, Calif.

LEARN Popular Piano! Play hit songs in boogie woogie style. Pianists send dime for sample arrangement. Home-study book or free. Christensen Studios, 748 Kimball Hall, Chicago 4, Ill.

IF you have a poem or song I will write a professional piano copy and obtain a copyright for you. Cliff Smith, Manager, Thain Music Mart, 334 E. Washington, Ft. Wayne 2, Ind.

SONGWRITERS! Send your poems for our offer and Free "Rhyming Dictionary." Phonograph Records made. Vanderbilt Music Studios, Box 112, Dept. 4M, Coney Island, N. Y.

SONGWRITERS. Write for Free Instructive Booklet. Outstanding Opportunities. United Music Corporation, Dept. 11, Salem, Indiana.

PHONOGRAPH Records Slightly used 20 cents each. Hoodwin Company, 4419 Broadway, Chicago, Illinois.

WANTED! Lyrics, melodies for songs. We arrange, publish, sell. Superior Song Studios, Passaic, N. J.

BAND Instruments, all Bargains. James Sistek, 12913 Broadway, Cleveland, Ohio.

OLD GOLD, WATCHES, PRECIOUS STONES

GOLD $35.00 Ounce—Mail old gold teeth, diamonds, jewelry, watches — receive cash by return mail. Satisfaction guaranteed. Free information. Dr. Weisberg's Gold Refining Company, 1500-E Hennepin, Minneapolis, Minn.

PATENT ATTORNEYS

INVENTORS Learn now without obligation how to protect and sell your invention. Secure Free "Record of Invention" form for establishing date of your invention—and Free Book "Patent Guide for the Inventor", containing complete information about patent procedure and selling inventions; giving illustrations of many successful inventions, over 150 basic mechanical movements. Delay may be costly. For prompt, confidential service—write—Clarence A. O'Brien & Harvey Jacobson, Registered Patent Attorneys, 32B M Adams Building, Washington, D. C.

INVENTORS Before disclosing your invention to anyone send for Form "Evidence of Conception," "Schedule of Government and Attorney's Fees" and instructions. Sent free. Lancaster, Allwine & Rommel, 413 Bowen Building, Washington, D. C.

PATENTS Secured. Two valuable booklets, "Patent Protection" and "When and How to Sell an Invention" together with valuable "Evidence of Invention" form sent free. Write immediately to experienced patent counselors, Victor J. Evans & Co., 541-F Merlin Bldg., Washington, D. C.

INVENTORS Send for free copy my 72-page book on patents. Reasonable terms. Prompt action. Confidential, personal service. L. F. Randolph, Dept. 340-A, Washington, D. C.

PROTECT your invention through medium of my expert personal service. Preliminary information without obligation. Horace L. Beall, 902 F Street, N. W. 4, Washington, D. C.

INVENTOR'S GUIDE free, containing 90 mechanical movements, information about patenting, selling inventions. Frank B. Ledermann, 154 Nassau St., New York.

"PATENT-Particulars" and Blanks, free. Established Sterling Buck, F-Hotel Plaza, Washington, D. C.

PATENTS

INVENTIONS Farsighted manufacturers already planning post-war sale of new non-military products. If you have a useful invention, patented or unpatented write Chartered Institute of American Inventors, Dept. 3 B, Washington, D. C.

PATENTS FOR SALE

NEW Invention for improving eyesight. Patented. Will sell for cash or royalty. Will also consider promotion plans. Unique Service, Glasgow, Montana.

PERSONAL

I WAS A Living Dead Man then I met God. As a result of this meeting I Re-discovered the Creative God Law and applied this Law in my own life. The results were amazing. The same Truths that I used to bring about my own rescue from "The Valley of The Shadow" and achieve Financial Independence, I now bring to you for your use in obtaining Financial Success, Love, Health, Happiness in your life, Here and Now. This Law is so amazingly simple and effective I want to tell you about it without cost to you. Send for Free copy of Your Birthright today, and learn how You may accomplish your Chief Ambition Now. M. C. Hutchison, Founder, The Nectarian Fellowship, Desk 32, 316 East 10th Street, Kansas City 6, Missouri.

ATTRACT Success, Health, happiness, through Ontology. Solve your problems metaphysically. Discover your real self. Ontology 5 minutes the Scriptures, teaches how to pray, reveals secret mind power. 24 page booklet Free. Alexander Keene, Sedalia, Missouri.

HEAT! No fuel worries. Costs less than 15c a day. New burner fits all coal furnaces. Build for $10 from our blueprints. 84 brings detailed instructions. Money back trial. Green B Co., Box 606, Mount Kisco, N. Y.

PSORIASIS Sufferers. Pixacol has brought relief when everything else failed. Caution: use only as directed. Apply externally, dries quickly, convenient. Try regular $1 bottle without investing a cent! Write: Pixacol Lab., Box 1298, Cleveland, Ohio.

PARENTS of young children—teach them how to Listen, think, remember and concentrate with our set of interesting play exercises. Benefits last throughout life. Special, only $1.00 postpaid. Kellogg, Box 1714 S. Portland, Oregon.

BEAUTIFUL hair can be yours without expensive treatments. This proven preparation nourishes the scalp and dresses the hair. 1 ounce jar $1.00. Alo-Cresco, Box 261, Belmar, N. J.

HEALTH, Prosperity and Happiness, through Problem Advice and Truth Treatments. Information free. Joseph Louis Peretz, 4612 Lindell Blvd., St. Louis 8, Missouri.

LIVE a life of abounding Happiness! Have Health, Wealth, Prosperity—Learn to attract Real Happiness and Success in your daily pursuits. Only $1.00. Ira G. Mercer, 639 Main Avenue, Passaic, N. J.

SLEEP Tight every night with Sleep-Rite Soft Wakeen Ear Noise Stoppers. Sample Free. Dowpos, 1213 Park Row Bldg., New York.

GORGEOUS Christmas Folders. 25 for Dollar or 50 for Dollar, your name printed free. Lefavor, Box 971, San Bernardino, Calif.

MEN amazing Hindu Secrets restore youthful pep and buoyant vigor. Free details in plain, sealed envelope. Hindu, 619 Eliot, Denver 4, Colorado.

25 THRILLING Pin Up Beauties—from original Hollywood Photos (exclusive release) $1.00. Libman Co., Dept. A, Box 7833, Del Valle Sta., Los Angeles.

'44 ESQUIRE Desk Calendars—Twelve Varga Girls—50c—Esquire Agent, 1919 Girard, Phila., Pa.

BUY Vitamins direct. Save. Postcard. Mateska Products, White Bear Lake, Minn.

HAND Guide, quickly corrects poor penmanship. Outline Free. Osment 6, St. Louis Mo.

HYPNOTISM Complete 20 Method Course 25c. Western Institute Hypnotism, D-1618, Palatine, Ill.

FEET Hurt? Cure your own, then cure others. Operate your own office. Details, dime. Sawyer, 732 P, Gainesville, Fla.

OIL paintings, on canvas. Reasonable. Box 66, R. R. 3, Randolph, Wis.

PHOTO FINISHING

IMMEDIATE Service! Pictures returned same day order received. Smashing Low Pre-War Prices. 8 sixteen guaranteed Deckled Edge Velox prints from roll 25c. Or one colored or two plain enlargements Free with 8 Deckled Edge prints, 25c. 16 reprints from negatives 25c. Candid Rolls developed. Magic Eye Timed. [illegible] and enlarged to 3 x 4 on Deckled Edge Velox Paper—36 exp. 35mm $1.00. 18 exp. 60c, 16 exp. No. 127, 50c. 8 exp. [illegible] 25c. Reprints 3 x 4 3c each. We have [illegible] perfect 35mm film! Low prices. Free Mailers, details on request. American Studios, Dept. 607, LaCrosse, Wisc.

BEAUTIFUL 4 x 6 pictures 3½c each from 116 and 120 negatives, 3½ x 4½ from all other sizes. All work guaranteed. Overnight service. Roll developed and 8 pictures 30c. Roll 12 pictures 45c. Roll 16 pictures 60c. Enlargements on double weight portrait paper 5 x 7 30c, 8 x 10 50c. Copies made from any picture 15c. Pacific Photo Service, Box 666, San Francisco, Calif.

BIGGEST $1.00 value in 35MM. [illegible] today. 36 exposure, fine grain 3¼x4¼ enlargements deckled, embossed margin and date. Eighteen exposures 75c. [illegible] picture up to 55c. Free mailers. 8 exposure rolls in beautiful deckled contact finish with embossed wide margin, 25c. Mailbag Film Service, Box 5440A, Chicago 80.

FREE Have your 35mm film developed by specialist. First film done free. Film fine grain developed. 36 big sparkling never fade 3 x 4 enlargements only $[illegible] 3½ x 5 $1.00. 18 exposures—75c. Satisfaction guaranteed! Overnight service. Free mailers, price list. Ministudio, Department [illegible] A, 2421 Greene, Westfield, N. J.

SPECIAL Offer. Hand colored 5" x 7" photo enlargement on professional double weight paper from film or photo, costs you only 25c. If easel frame desired add 10c. No extra charges. Include color hair, eyes, etc. Send only coin or money order. Dept. W, Box 161, Station D, N. Y. C.

OIL coloring photographs a fascinating hobby or profitable business. Learn at home. Easy simplified method. Previous experience unnecessary. Send for free booklet and requirements. National School, 1315 Michigan, Dept. 17N, Chicago.

6-8 EXPOSURE Films developed and finished 25c. 12-16 exposures 35c. 18-20 exposure 35mm films 50c. 36 exposure $1.00. Reprints 2c. 100 reprints $1.50. Send for beautiful free 8x7 enlargement and mailing bag. Photo Service, Box 5450-Metropolitan Station, Los Angeles, California.

REPRINTS 2c each fifty or more; less than fifty 2½c each. Rolls developed and printed 25c. Finest workmanship; fast service. Mercury, B-100, North Dearborn, Chicago, 2.

ROLL developed and 8 beautiful enlargements 2 to 8 times larger—deckled edge—high gloss. Any 8 exposure roll 25c coin. Reprint enlargements 3c each. Alden Photos, 94-4 Astor Station, Boston, Mass.

FILMS Scientifically developed, plus 8 beautiful 4 x 6 enlargements, 30c complete. Photo Service, 107 Dewey St., Newark, N. J.

ROLL Developed, photo album, 2 enlargements, 8 prints, 25c. Geppert Studios, Dept. J-2, Des Moines, Iowa.

QUALITY Photostamps from any snapshots $1.00 per 100. 82-30 60th Road, Elmhurst, N. Y.

POULTRY & SUPPLIES

LEARN about Wartime Poultry Raising. Real profits can be yours raising Poultry the American Way. Monthly helps and suggestions, short cuts that save time and money. Free bulletins. Personal help from poultry experts and monthly poultry magazine published since 1874. Costs less than 3 cents monthly. 25c year; 5 years $1.00. Send coin or stamps today. American Poultry Journal, 523 S. Clark, Chicago.

MONEY-Saving Poultry Tips from Experimental Farm, on feeding, laying, marketing. Subscribe today. One year 25c. 5 years $1.00. Poultry Tribune, Dept. 152, Mount Morris, Ill.

PRINTING, MULTIGRAPHING, MIMEOGRAPHING, LABELS

"PRINTOMATIC" Self feeding Rotary Stencil Post Card Printer $9.50 Complete. All Makes Duplicator Supplies. Literature Free. Pittsburgh Typewriter Supply, 336 MA Fourth Avenue, Pittsburgh 22, Pa.

LABELS, Tags, Stationery, Booklets, Circulars, Ruled Forms, Cards, Blotters, etc. We Print Anything. Write for estimate on your needs. Price List and Samples Free. Edgewood Press, Box C-367, Edgewood, Maryland.

$2.00 POSTPAID: 200 8½ x 11 Good Bond Letterheads and 200 6¾ White wove Envelopes. Good workmanship, quick delivery. Mero Products, Box 244, Punxsutawney, Pa.

500 LETTERHEADS 8½ x 11 and 500 6¾ envelopes, printed in attractive type on good bond paper, $4.75 postpaid. G. H. Hayes, Box 1654, Jacksonville, Fla.

PERSONAL Xmas Cards. 22 French Fold 942 Quality. Name Printed Free. $1.00 Cash, Check or M. O. Edgewood Press, Box C-367, Edgewood, Maryland.

CLASSY printing economically produced. Quick deliveries. Samples. Sicuran, 4348 Windham, St. Louis 20.

75 8½ x 11 Hammermill Letterheads and 75 Whitewove Envelopes, $1.00. Postpaid. Bersey[illegible] 907 West Roosevelt, Phila.

DISTINCTIVE Stationery at Reasonable Prices. Samples free. Stump Printers, South Whitley, Indiana.

200 BOND Letterheads, Envelopes. Per 2000—$5.90. Samples. Joseph Johnson, 1342 B Fifth Ave., New York 29.

PRINTING and labels all kinds, samples. Printrite, 39 Banks, Asheville, N. C.

500—8½ x 11 Letterheads $3.95. Saxon, 7814? Franklin, Cleveland, Ohio.

DISTINCTIVE Printing Reasonably Priced. Free Samples. Cramer, Box 993, Chicago.

PRINTING OUTFITS & SUPPLIES

PRINTING Outfits and Supplies. Send stamp for details or dime for complete illustrated supply book. Kelsey Inc., W-8, Meriden, Conn.

PROFESSIONAL stencil post card printer, complete $2.66 postpaid. Challenge Association, D-10, Cincinnati.

INEXPENSIVE home-made printing press. Details free. Novelty Shop, Downsville, Louisiana.

PRINTER'S Supply Bargain Catalog. Send stamp. Bradshaw, 3214-B Huron, Chicago 24.

PRINTING Presses, Type, Supplies. Lists 3c. Turnbaugh Service, Loysville, Pa.

USED printing equipment. Prices free. [illegible]

PROFITABLE OCCUPATIONS

MECHANICALLY Inclined Men—Own and operate general Appliance Repair shop. Complete, illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business—all phases covered. Free literature. Christy Supply, Dept. 1034, 2835 N. Central Ave., Chicago.

LOCKSMITHING Course. Practical inexpensive lessons for handy men. [illegible] Pick locks, decode, make masterkeys. Satisfaction guaranteed. Send for Free Details. Nelson Co., 321 South Wabash, Dept. 709, Chicago.

OPERATE your own Refrigeration Repair Shop. Good jobs now and after the war. Easily learned at home. Common education sufficient. Free booklet. Mechanics School, Dept. S-20, 4701 West Pico, Los Angeles 6.

RAISE Highly-Profitable Angora Rabbits. Wool brings $4.50 pound. Plenty markets. Send 25c for Literature, Instructions, Prices. Wm. White Angora, Crawfordsville, Ind.

$40.00 WEEKLY. Made growing mushrooms. Fresh. Dried. Dominion Patent 331543, free spawn, North American, 1097 Yonge, Toronto, Canada.

$5000 FROM Half Acre! Growing Ginseng Seed, contract supplied. Particulars 10c. Associated Growers, Dept. 12, St. Norbert, Manitoba.

GROW Mushrooms in boxes. Instructions 25c. Spawn $1.00. Gordon, 853 William, Winnipeg, Man.

"RAISE Earthworms for Profit." Information free. Bureau of Zoological Research, 106-A Broadway, Peoria, Ill.

RADIOS, SUPPLIES & INSTRUCTION

REVISED Plans 18 Crystal Sets (SW record 6300 miles), with "Radiobuilder"—25c. Laboratories, 1606-T 17th Avenue, Oakland 3, Calif.

RADIO Service men and experimenters send for our giant radio catalogue. Save dollars. United Radio Co., (1000-V), Newark, N. J.

MIRACLE point $1 phonograph needle plays 2000 records, plus money-saving Parts and Tube catalog all for 25c. Radio Warehouse, 365 Wooster, Akron, Ohio.

LOWEST Prices. Radio Tubes, Parts. Free bargain lists. Potter, 1314-A McGee, Kansas City, Mo.

"RADIO Construction and Repairing"—[illegible] page, illustrated workbook—$1.50. [illegible], Box 103, Thomaston, Conn.

CRYSTAL Radio Experimenters. Write Hulet, 29 E. 39th, New York.

RARE COINS

COIN Collectors Read The Numismatist. Published monthly. News, illustrated feature articles on coins and medals. Sample copy 25c. American Numismatic Association, 80 Livingston St., Brooklyn 2, N. Y.

FREE Foreign coin, banknote and Coin Collecting illustrated Catalog to approval service applicants. Send 3c postage. Up to $20 cash paid for Indian head cents. All dates wanted. Hard[illegible] 15c. Tatham, [illegible] Springfield [illegible] Mass.

CENTS 100 years old 25c. Indians, 10 different 25c. New 1943s cent and nickel 15c. San Francisco Mint Lincolns 10 different 25c. 1933 Dollar $1.50. Big illustrated coin book 50c. Coins, Box 77, Alameda, Calif.

WILL Pay $10.00 each for certain Lincoln Pennies! Indianheads $50.00. Dimes $1,000.00. Catalogue 10c. Federal Coin Exchange, 41 PS, Columbus 15, Ohio.

COMPLETE Catalogue of all U. S. coins [illegible] to $[illegible]00. 75 Illustrations, 3500 Quotations. Price 10c. James Randall, 341 South Dearborn, Chicago.

10 INDIAN Head cents, different dates, also pricelists, 35c. Schultz, 1053½, Richmond, Cincinnati, Ohio.

HOBBY News with large premium 35c a year. Keim, Box 103, Sta. A, Flushing, N. Y.

WE purchase all Indianhead pennies. Complete catalogue 10c. Waltman, 398 Broadway, New York.

FIVE foreign bills, 25c. Twenty-five different $1.00. Madel, Box 37-A, Ottawa, Illinois.

25 DIFFERENT Indian Cents $1.10. Large [illegible] Catalogue 5c. Hebee Coin Company, [illegible] Chicago.

COINS of The World. List free. Harry Ela[illegible], Pittsburgh, Pa.

RAZOR BLADES, SHAVERS

"CUT Own" Hair Cutting Comb. Perfect. 75c. 830 Main, Aurora, Ill.

REPAIR WORK

FOUNTAIN Pens — Repaired Expertly, Guaranteed to Write Beautifully. 50 cents. Immediate Service. Universal Pen Repairs, Box 70, Brooklyn 29, N. Y.

RUBBER STAMPS

3 LINE stamp 30c, cushioned, indexed, 35c. Signatures $1.50. Printive, Wauwatosa, Wis.

ONE line 15c, 2 lines 25c, 3 lines 35c. Excello, Box 500, Shreveport, Louisiana.

CUSHIONED, 3 lines 45c, signatures $2. Federich Mfg., East Pittsburgh, Pa.

SONGWRITERS

SONGWRITERS. Our service includes free revision, melodies without charge, song recording and manuscript lead sheet copies. Cinema Song Company, Box 670B-6, Beverly Hills, Calif.

SONGWRITERS! Send your poems for our offer and Free "Rhyming Dictionary". Phonograph Records made. Vanderbilt Music Studios, Box 112, Dept. B-M, Coney Island, N. Y.

DO you have a complete song? Are words and music ready for the Press? Don't send song. Write for our Royalty Publication Contract first. Puritan Publishing Co., 343 So. Dearborn Street, Chicago 4.

SONGWRITERS: Write for free booklet, Profit Sharing Plan. Allied Music Company, 204 East Fourth, Cincinnati, Ohio.

SONGWRITERS Send Poem For Immediate Examination and Free Rhyming Dictionary. Richard Brothers, 46 Woods Building, Chicago.

POEMS Wanted For Musical Setting. Send poem for immediate consideration. Five Star Music Masters, 640 Beacon Building, Boston.

SONG Poems Wanted. Write for Free Instructive Booklet, Outlining Opportunities. United Music Corporation, Dept. 36, Salem, Indiana.

GOOD Music Composed to Good Words. Music Printing. Reginald Belcher, Chatham, New Jersey. Established 1910.

SPORTING GOODS, GUNS, FISHING TACKLE, ARCHERY

GUNSMITHING Readily learned at home. Earn extra money repairing neighborhood's firearms. Free catalog 25 firearm and gunsmithing textbooks. Samworth, Plantersville, South Carolina.

BOWS-Arrows for Recreation-Hunting-Fishing. Beautiful Archery instruction book, 90 pages, 50 illustrations, only 50c. Illustrated catalogue Free. Archery, 617 South State, Chicago.

USED Guns, Binoculars, bought, traded, sold. Ammunition bought. Highest Cash Prices Paid. Sturger Arms Corp., 507 Fifth Ave., New York, N. Y.

270 ANTIQUE Firearms, Swords, Cartridges, Rifles, Indian Relics. Catalog, 10c. Photographs of Most Heske, Wenona, Ill.

ARCHERY Equipment. Catalogue Free. Mid West Archery, 2300 O East 75th, Chicago 49.

USED guns, bought, sold, exchanged. List stamp. Howe, Coopers Mills, Maine.

SEND 10c for list 100 used Guns. Frayseth's, Willmar, Minn.

STAMP COLLECTING

FREE! The United States has issued its most remarkable series, 12 stamps, each showing the flag in full colors of over-run nations. Our contribution is a special album worthy of housing these colorful and historic stamps. It's a fine album, 34 pages with front cover by a famous artist, artistically arranged and telling the history of each of the 12 nations so honored. We will send it Free for your handling and mailing expenses to serious approval applicants. Send for yours today and kindly state whether approvals shall consist of U. S. or foreign or both. Approval Headquarters, Globus Stamp Company, 268 4th Avenue, New York City 10, Dept. 2 [illegible]

WOW! $10.00 Worth of Fun for only 10c! 500 Foreign Stamps, unsorted and unpicked (mostly on bits of paper) just as received from the church missions and other sources. Africa, So. America, Australia, China, Philippines, Dutch Indies and other countries are represented. Includes a few commemoratives, airmails and stamps catalogued up to 25c or more each. The biggest Package of Fun in Stampdom and you might find something really valuable! Price only 10c to serious approval applicants! Money back if not delighted. Jamestown Stamp Co., Dept. No. 6, Jamestown, New York.

FIND Stamps Worth Fortunes! Six Big Items. Queer Countries Packet: D[illegible] South Quaiti[illegible] etc. Packet scarce Russia. Catalog price 50c. Fine packet of 25 different British Colonies: Turks & Caicos Islands, Hyderabad, Jamaica, etc. United States $4.00 and $5.00 high values. Big Far East packet of 30 different stamps from Dutch Indies, Siam, Philippines, etc. Illustrated 32 page booklet—tells where to look for, and sell, stamps worth up to $10,000 apiece! Everything for only 5c to approval service applicants!! Mystic Stamp Company, Department 155, Camden, N. Y.

FREE The Stamp Finder. Send today for big new edition, fully illustrated, enabling you instantly to identify all difficult stamps! Also fine packet strange, fascinating stamps from Bosnia Herzegovina, Monaco, Patiala, Cyprus, etc., including maps, ships, animals and strange scenes. All free to approval applicants enclosing 3c postage. Garcelon Stamp Co., Box 9[illegible], Calais, Maine.

POSITIVELY Greatest Free Offer. Latest Scott's International $4.00 Stamp Album—covering entire World; contains 36,000 illustrated, descriptive spaces. Scott's 1944 Standard $5.00 Catalogues "Philatelic Encyclopedia"—absolutely Free to applicants for Foreign Approvals becoming customers. Plymouth, A. J. Bell, California.

FINE Approvals, freshly mounted. Fast, personal service. Tell me what countries you prefer and I'll send their stamps. Milton Skinner, 345 East Ocean, Long Beach, Calif.

120 ALL different U. S. $1.00. Old, new issues. Coins, Postage—Dues, Famous Americans, Airmails, etc. Good condition. Lightly cancelled. Guaranteed to please. Try our foreign packets 10c each, 3 for 25c, 14 packets $1.00. All different. Bargain Approvals sent on request. Armour Stamp Co., St. Albans, N. Y.

WORLD'S Largest Diamond And Triangle Stamps. Free Stamp Magazine, Stamps from Fighting Free French. 25 stamps from 25 different United Nation Countries. Pictorials, Airmails. Big Bargain 3c with approvals. Capital Stamps, Dept. 10, Little Rock, Ark.

FREE United States Greece handsome First Day Cover franked with full colored New Flag Commemorative, to new applicants requesting Foreign approvals (Postage 3c.). Intercity Co., Port Washington, N. Y.

SMOKY Mountain commemorative sheet, largest U. S. stamp issued, and 33 U. S. including commemoratives, airmail, revenues, etc. Catalog 75c—To approval applicants for 3c. Cyrhan Stamp Company, Dept. C, Gloucester, Mass.

127 DIFFERENT Stamps including Free Fighting French, Haiti, Johore, Perak, only 10c to approval applicants. Beck Stamp Co., 4047 Kenmore, Chicago, Dept. 87.

BONANZA Old, new issues, mint, used, commemoratives, dues, blocks, revenues, pictorials, from sixteen countries, about 100 stamps as they come, only 50c! Phoenix, 111 Sycamore, Cincinnati, Ohio.

115 DIFFERENT stamps including Commemoratives, Charities, Airmail sets, etc. 3c with Approvals. We buy Stamp Collections. Badger Stamp Company, Milwaukee 8-J, Wis.

19TH Century U. S. Commems., Civil War Revenues, Battleships. $5 & $10 Stamps Free to U. S. Approval Applicants. Metropolitan Stamps, 100-G Broadway, New York.

BRITISH Empire Collection! Burma, Cyprus, Gwalior, Selangor, Tasmania. Also 50 other British. Only 5c with Pictorial and Commemorative Approvals. Lyman, 92 Nassau, New York City.

UNITED STATES Numbers 93, 144, 285, 397, 790, 507, 729 [illegible] Send 25c. Approvals forwarded. Whiton Stamps, Westport, Conn.

FREE—Canadian Sets, Royal Visit, George VI, George V, Coronation, Jubilee. Others, to approval applicants. Ensign, Box 1 E P, So. Orange, N. J.

UNITED STATES approvals complete coverage, fine quality, attractive prices. Seminole Stamps, Box 436, Coconut Grove, Florida.

SPECIAL—Airmails 21 different including Zeppelin, Triangles, Latin America, etc. 5c with approvals. Continental Stamp Co., Box 400, New Rochelle, New York.

70 DIFFERENT including Tunisia, Australia, Indo-China, 5c approval applicants. Ransom, 1233 Pontiac, Ann Arbor, Mich.

FREE—Your choice of any 10 stamps from our first U. S. Approval selection. Illustrated list included. Cosmopolitan Stamp Company, 1457 Broadway, Dept 6P, N. Y. C.

FREE! Complete "United States" stamp catalog with 1,000 illustrations! Send 3c for postage. Harris & Co., 80 Transit Building, Boston, Mass.

SOLOMON Islands, Seychelles, Nejd, Caymans, Manchukuo, Brunei. Everything 3c with approvals. Viking, 130 (P) Clinton St., Brooklyn, N. Y.

POSITIVELY Free! Scott's latest $5.00 International Stamp Album or 1944 Catalogue to approval customers. Claire's, 1460 Bayparkway, Brooklyn, New York.

EUROPEANS, British and French Colonials, South and Central America Approvals. Henry Zimmer, 722 Culver Road, Rochester, New York.

1000 MIXED U. S. no current, includes 3c 87 & department $1.75. New Hussman Stamp Co., 1122 Pine St., St. Louis 1, Missouri.

PHILATOPIC Monthly Free—Forty pages—profusely illustrated. Includes Stamp Encyclopedia. Empire Stamp Company, Dept. PR, Toronto, Canada.

FREE Outfit! Album, stamps, hinges, gauge, detector 3c. Generous foreign approvals sent. Manchester Stamp Company, Manchester, Conn.

25 DIFFERENT Asiatic stamps free. Quality penny approvals included. Harding Stamp Store, 3031 N. Harding, Chicago 25, Ill.

50 DIFFERENT Persia (Iran) 25c approvals. Pinehurst Stamps, 99 Pinehurst, New York 33.

FREE Stamps for new approval buyers. Armstrong, 46 Jeannette, Youngstown, Ohio.

FREE—New Union South Africa War Set to Approval Applicants. Charles Cleveland, 506 North Humphrey, Oak Park, Ill.

DUPLICATES Exchanged. Send 100 different stamps and 25c for 100 different stamps. Garrow, 600 W. 138th, New York.

SAVE! Buy new foreign stamps as they are issued. Information Free. Raymond Koch, Muscoda, Wisconsin.

U. S. Nos. 345, 356, 308, 370, 398, 548, 549, 770, 10 others 25c. Approvals accompany. Horace Paine, Westport, Conn.

ZOOIE! Afghanistan, Siberia, banana airpost, etc. 3c with approvals. Saxon, Valley Stream, N. Y.

FREE! Pony Express set (facsimiles). Postage 3c. Roberts, 401 Shearerbldg., Baycity, Mich.

FREE! Western Hemisphere Packet. Postage 3c. Owens, 801 Wenbhldg., Baycity, Mich.

FREE "British Empire Packet." Postage 3c. Williams, 601 Archerbldg., Baycity, Mich.

CHILE 20 Different Free! Approval applicants—3c return postage. Win-Rad, Box 31(S), Rugby Station, Brooklyn, N. Y.

PAPUA! Scarce coronation set, complete unused—10c. Neumaceg Stampco, Newton Lower Falls, Mass.

U. S. 50 Different 5c to Approval Applicants. Neumann & Co., 1506 W. Oklahoma Ave., Milwaukee 7, Wisconsin.

50 DIFFERENT United States 5c with Approvals. Bookman, Box 145-P, Maplewood, N. J.

25 DIFFERENT with triangle, air, commemoratives, 5c with approvals. Knowles, Box (1)7, Baltimore, Md.

MEXICO Census Commemorative Set. Free with approvals. Pladon Stamps, 1717 S. Idaho, Toledo, Ohio.

BARGAINS in fine approvals! Write today. International Stamp Co., Hallettsville, Texas.

A $2,000 stamp plus 50 different, 3c with approvals. O. Knapp, Box 1321, Bristol, Conn.

BIG Bargain! 100 Different United States 10c. Monjar, 1760 Fairmount, Cincinnati, Ohio.

ARMY Navy Set—No. 785 No. 794. These stamps lightly cancelled 15c. Lincoln Exchange, 173 Columbia, Irvington 1, N. J.

60 DIFFERENT United States, incl. Commemoratives, 10c. Pricelist free. Seidenberg, Baroda, Michigan.

SEND for inexpensive approvals. Brady Stamp Service, 560 Ashmont, Dorchester, Mass.

TRY my low, medium, approvals. Bargains. Frank Carr, Jr., Pompton Lakes, N. J.

NEWFOUNDLAND assortment worth 50c only 5c approvals. Minutemen, 516 Massachusetts, Lexington 73, Mass.

$2.00 CATALOG value, only 10c to approval applicants. Lon[illegible], S-1360 Pacific, St. Paul 6, Minnesota.

UNITED STATES stamps on approval. Large stock. Box 465A, Minneapolis.

10 FINE U. S. 1862—1903, 3c. Weston, Box 30, Oklahoma City, Oklahoma.

CURAÇAO Set new issue 10c with approvals. Vargo Stamps, Racine, Wisconsin.

FIFTY Stamps for 5c with approvals. Stanley Gardner, Salyersville, Ky.

TRY my 1c Approvals. Chick, 713 High St., Bath, Maine.

U. S. Mixture three pounds, $1.00. Holmes Stamps, New Albany, Ind.

SOUTH Pacific—30 different 25c. No approvals. Elsea, Bowling Green, Ohio.

MISSION Mixture—Foreign $1.00 pound; U. S. 50c. Stamps, Box 64, Racine, Wis.

U. S. COMMEMORATIVES 60 Different, 25c. Crystal Stamp Co., Racine, Wis.

PENNY Approvals that satisfy. Nat. Gronberg, Box 344-S, Philadelphia 41, Penn.

1000 MIXED U. S. Old and New 25c. 3 lbs. $1.00. Weatherby, Troy, Ohio.

NO Special Offers! Our approvals speak for themselves. Phil[illegible], Arcadia, Calif.

NEW Approvals; applicants wanted, write—Streiner, 1020 East 61, Cleveland, O.


Pretty Special!
The man with
*Pipe Appeal
PRINCE ALBERT
CRIMP CUT
WOMEN have an extra smile for the man who smokes a pipe. Keep 'em smiling! With real PIPE APPEAL—Prince Albert's fragrance, bland aroma. And favor yourself with P. A.'s no-bite mildness—the rich taste that comes through so mellow. Prince Albert outsells every other smoking tobacco—it's the brand for all out PIPE APPEAL!
50 pipefuls of fragrant tobacco in every handy pocket package of Prince Albert
70 fine roll-your-own cigarettes in every handy pocket package of Prince Albert
Try P.A. for MILDNESS and that choice-tobacco RICHNESS!
BUY WAR BONDS AND STAMPS!
*PRINCE ALBERT
THE NATIONAL JOY SMOKE

Guns That Point at Tokyo

Fighting craftsmanship *by Fisher*

The Army-Navy "E" flies above four Fisher plants for excellence in aircraft production and from two others for tank production, while the Navy "E," with four stars, is flown by still another Fisher plant for its naval ordnance work.

THIS new naval dual-purpose 5-incher is bringing added advantages in fire power to our armed forces at sea and on invasion coasts.

Here at Fisher, we take particular pride in it, even though we do not make *all* of it.

For the skills we have developed go into it. All the crafts we have mastered are concentrated on it. It represents the many kinds of Fisher craftsmanship combined in a fighting tool that gives our men the all-important edge.

We believe in armament that holds an actual combat advantage within itself. That's wh we throw our reserve of fighting craftsman ship into every tank, bomber or gun w build. And our fighting men tell us that it' an added advantage when the going get tough.

• • •

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AI
NBC Network

armament ~~BODY~~ BY Fisher

IVISION OF GENERAL MOTOR

IF the Jap fleet ever decides to come out and fight, it will run into the devastating fire of the most powerful naval cannon that engineering and metallurgy can produce

By ARTHUR GRAHAME

Drawings by FRANK HUBBARD

RIVALRY between makers of warship armor and of guns and projectiles to smash it—a never-ending contest reaches a higher pitch today than ever before.

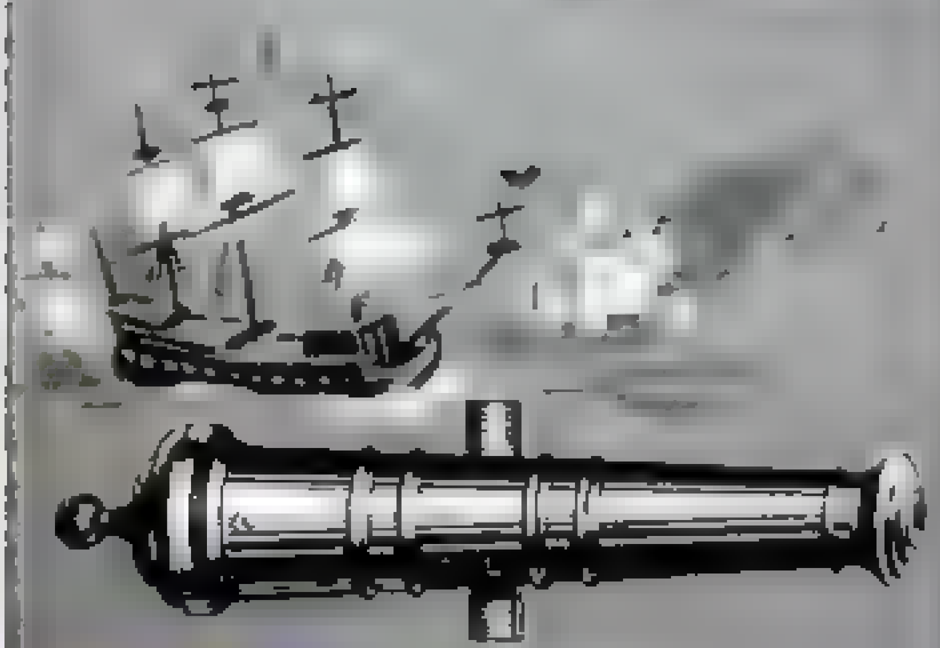
Thundering turrets of hostile men-of-war are proving that no weapon has yet outmoded naval artillery. Both in engagements of limited scope, and in the Allies' grand clash with Japan's main fleet that some observers predict will once and for all settle the control of the seven seas, the clang of metal against metal may well be the final arbiter.

Will a shell penetrate the vitals of an enemy ship, where it will cause enormous havoc when it explodes? Will it get stuck halfway through the armor and do only minor damage? Or will it harmlessly glance off the ship's protective belts of steel? Questions like these preoccupy the U. S. Navy's Bureau of Ordnance, just as similar problems confronted designers of the first cannon used aboard ships in the year 1400 or thereabouts. Highlights of developments from that time to the present offer an illuminating glimpse of the evolution of naval gunplay.

What we now call fire power first became recognized as the decisive factor in war at sea when the superior shooting of Sir Francis Drake's English fleet defeated the Spanish Armada in 1588. Drake's cannon were crude weapons of brass or iron, cast hollow

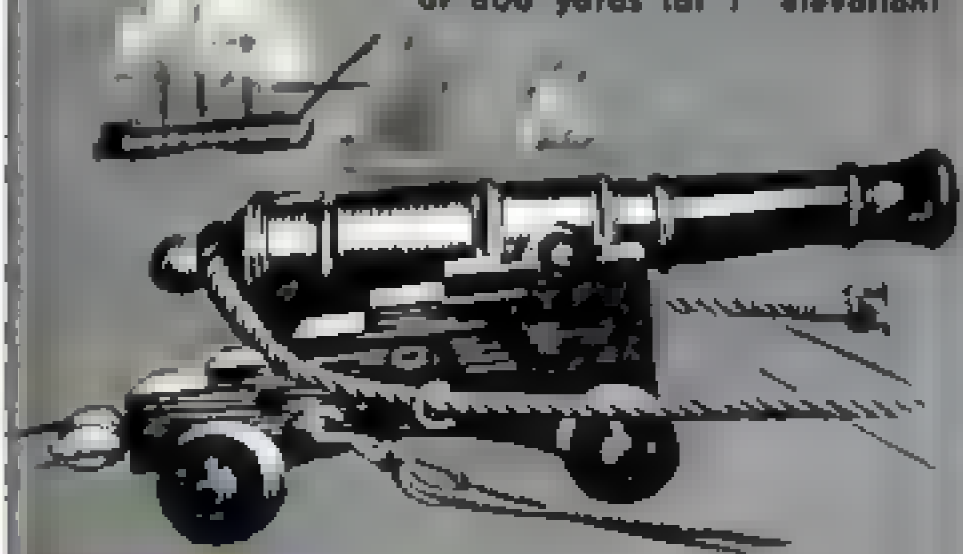
THE BIG GUNS SPEAK. Here the 35,000-ton U.S.S. *North Carolina* cuts loose with three of her nine 16-inch rifles, most powerful engines of destruction used at sea

THE EVOLUTION OF



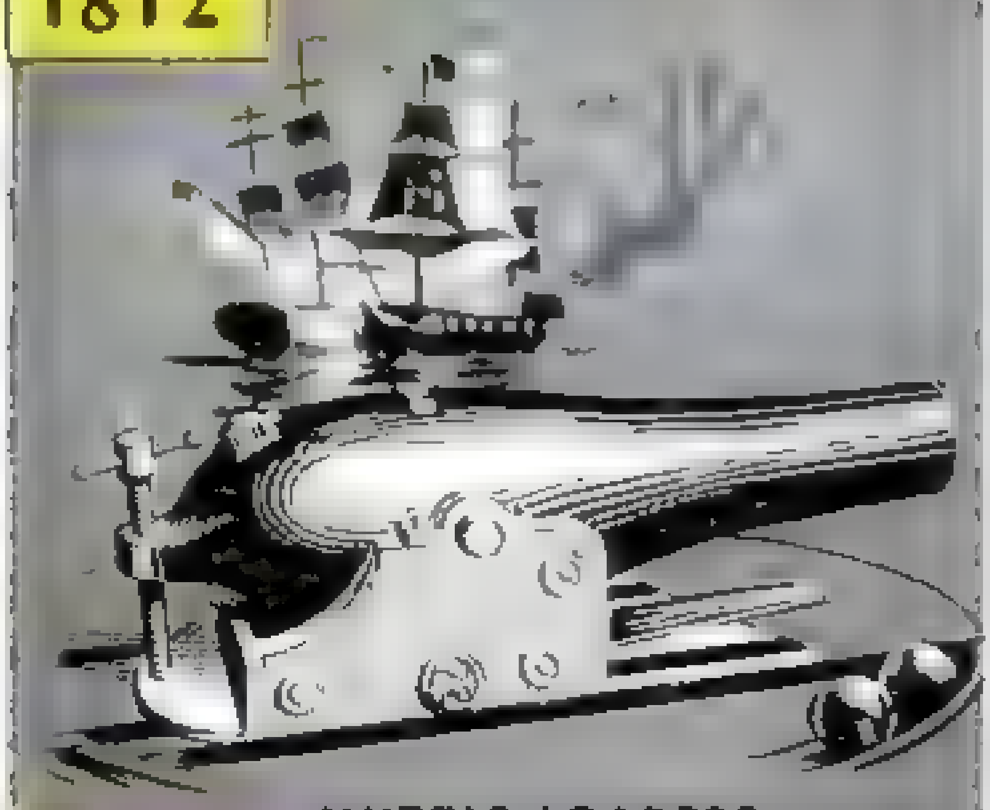
1588

HOLLOW-CAST guns like this 24-pounder stone-shot cannon licked the Spanish Armada, proved supremacy of gun power



CAST SOLID and bored out, the 24-pounders mounted by "Old Ironsides" had a range of 600 yards (at 1° elevation)

1812



1856

MUZZLE-LOADERS reached their peak in the Dahlgren gun. Pot-belly resisted high chamber pressure

on a core, but they packed the punch that brought him victory.

About 1750, a Swiss mechanic invented a boring machine, which made it possible to cast a cannon solid and then bore out its barrel with reasonable precision. Guns made in this way were more powerful and accurate than the hollow-cast kind.

By the year 1805, when the British defeated the French and Spanish in the celebrated naval battle of Trafalgar, Nelson's victorious ships of the line mounted the best guns of their time. These 32-pounders—so called from the weight of the iron cannon balls they fired—measured nearly 10 feet long and weighed three tons. Their point-blank range was 350 yards, the distance at which decisive sea engagements then were fought; and their extreme range, a mile and a half. Probably their penetrating power compared with that of the foot-longer 24-pounders carried by the U. S. frigate *Constitution* in the War of 1812—22 inches of oak at 1,000 yards. Including smaller weapons, Nelson's biggest ships were armed with considerably more than 100 guns apiece. But when about half of them fired a broadside, they sent no more than 1,300 pounds of iron hurtling at the enemy—less than two thirds the weight of a single armor-piercing projectile from a modern 16-inch gun.

A momentous advance in naval gunnery—the introduction of explosive shells—came in 1822. Paixhans, a French artillerist, designed an eight-inch flat-trajectory cannon whose 62-pound shell contained a bursting charge of four pounds of black powder. Tests proved that this projectile had a tremendous incendiary effect upon a wooden ship. But conservatism in the French Navy was so strong that the new weapon was not adopted until 1837. The British hesitated two years more before producing a similar shell gun, to be used along with their time-tested 32-pounders.

For 15 years after the French and British began arming their ships with shell guns, neither did anything useful about protecting their ships from these weapons. After a few sketchy trials in which guns shot holes through thin cast-iron plate, it was decided offhand that armor was no good.

Gunmakers made the most of their temporary advantage. Muzzle-loading, smoothbore cannon reached the peak of their development in America, with production, by 1856, of Dahlgren guns

for our Navy, ranging in bore from nine to 11 inches and capable of firing either shells or solid shot.

Advocates of armor now saw the doom of warships lacking it. The world's first seagoing ironclad, *La Gloire*, completed by the French in 1859, sheathed her wooden hull with armor plate 4½ inches thick. Britain countered in 1861 with the *Warrior*, an all-iron warship with the same armor thickness. Across the Atlantic, spurred by the Civil War, Federal and Confederate forces were racing to complete the first American ironclads —the celebrated *Monitor* and *Merrimac*. It was almost a photo finish.

Hardly had the Confederate rebuilt frigate begun sending wooden Federal ships to the bottom before, on the morning of March 9, 1862, the Federal warship *Monitor* arrived at Hampton Roads, Va., and went into action. It was the first time in history that ironclad tangled with ironclad. Neither ship won a decisive victory. The *Monitor's* two 11-inch Dahlgren guns—the same size as those on Germany's "pocket battleships"—were mounted on a revolving turret that went out of order during the battle. Nevertheless, the "cheesebox on a raft" was able to outmaneuver the unwieldy *Merrimac* and to present a small target for her 10 guns, of which the largest were nine-inch Dahlgrens. The net result was that the *Merrimac's* four-inch bars of armor and the *Monitor's* five-inch side armor and eight-inch turret armor were only dented. At least, the legend of the all-conquering *Merrimac* had been buried at sea.

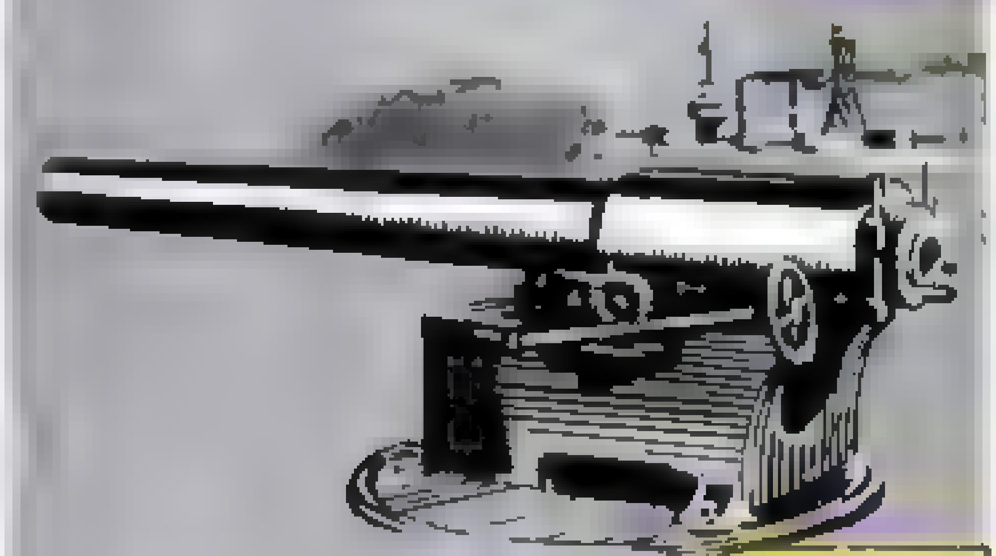
The next move was up to the gunmakers. Their answer was to substitute rifled guns for those of smooth bore. True, some of the *Merrimac's* smaller guns had been rifled, like those of the British *Warrior;* but none had received extensive trials.

Rifling consists of a helical-shaped insert within a gun barrel, which spins the projectile as it leaves the gun. This steadies a shell in flight, so that it keeps accurately headed for its target instead of tumbling over and over. But there was another advantage of rifling that attracted early designers.

Smoothbore guns wasted power. Round shot had to fit so loosely, to avert danger of explosion if it stuck in the bore, that a quarter of the propelling gasses escaped around it. Ri-

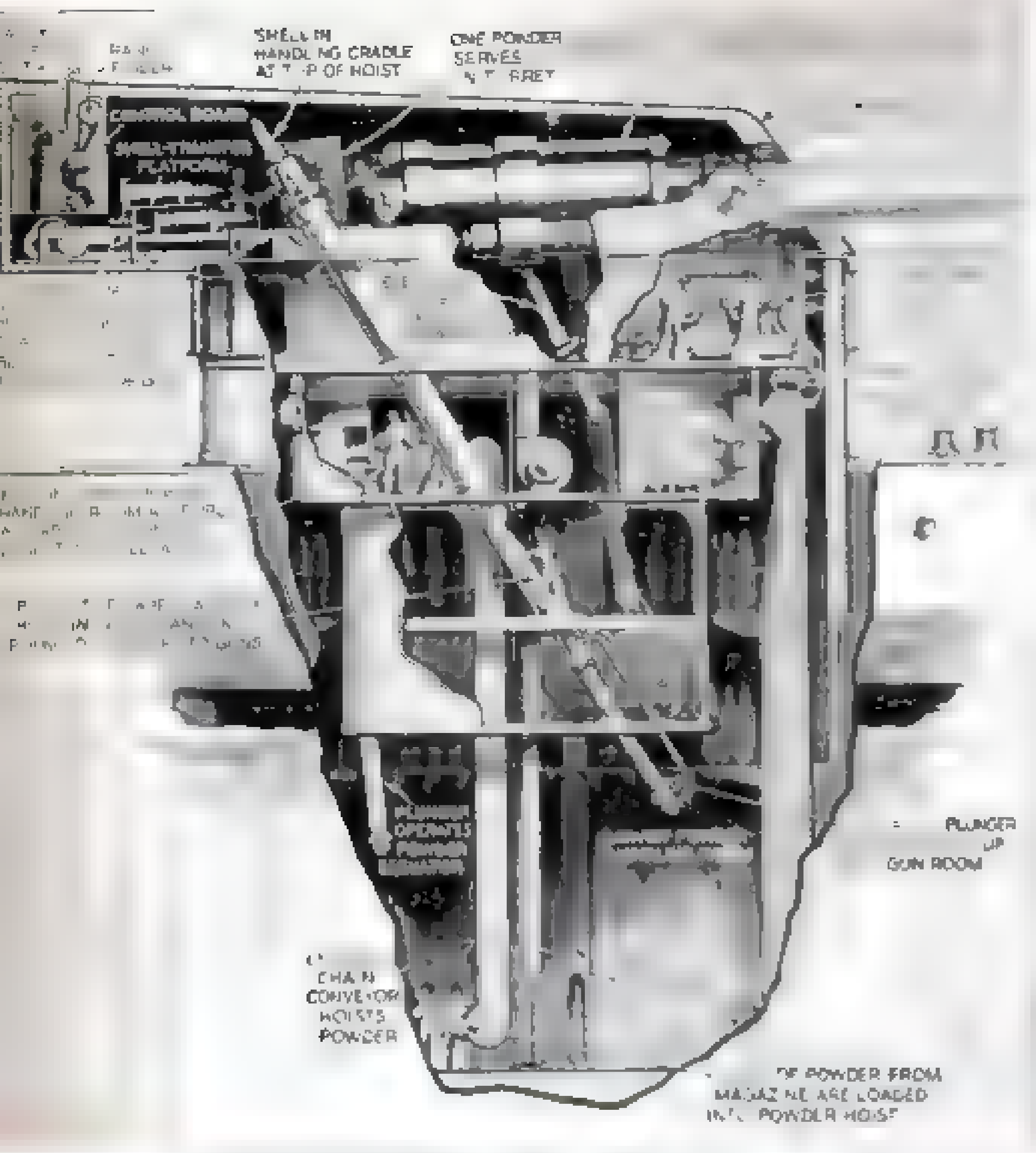
RIFLING brought greater accuracy and eliminated the power waste that was a great fault of smoothbores **1857**

TURRETS and armor got their big test when the *Monitor* and *Merrimac* fought the first duel of ironclads **1862**



BREECH-LOADING rifles of high power armed the new American Navy that was to win the Spanish War **1891**

WORLD WAR I found major navies using long-barreled, hooped-steel guns and nitroglycerin powders **1917**



A MODERN TURRET GUN

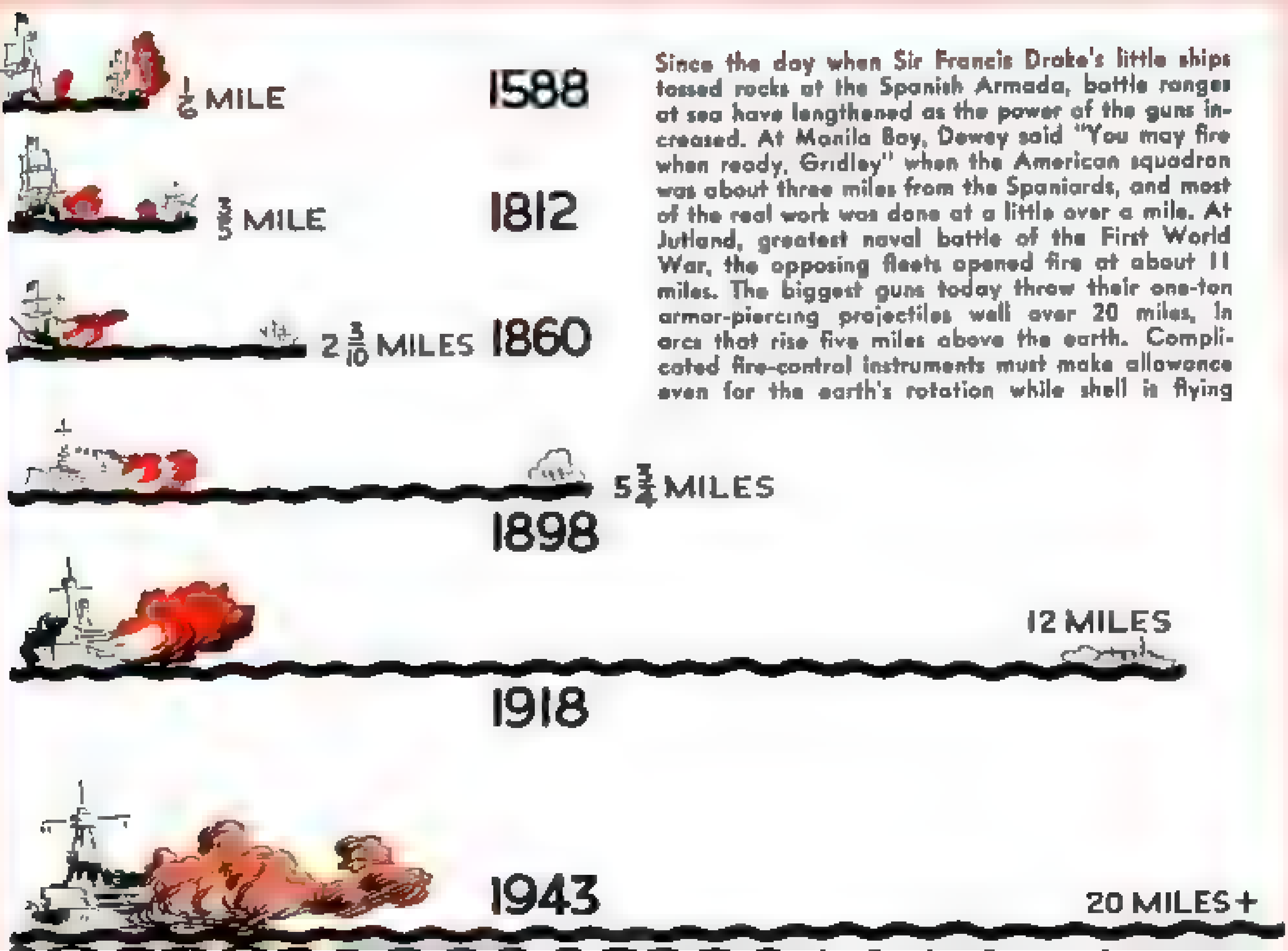
Larger-caliber guns are mounted three to a turret. This drawing shows the plan of a 16-inch-gun turret on one of our older ships

fling permitted the use of an elongated, tight-fitting projectile.

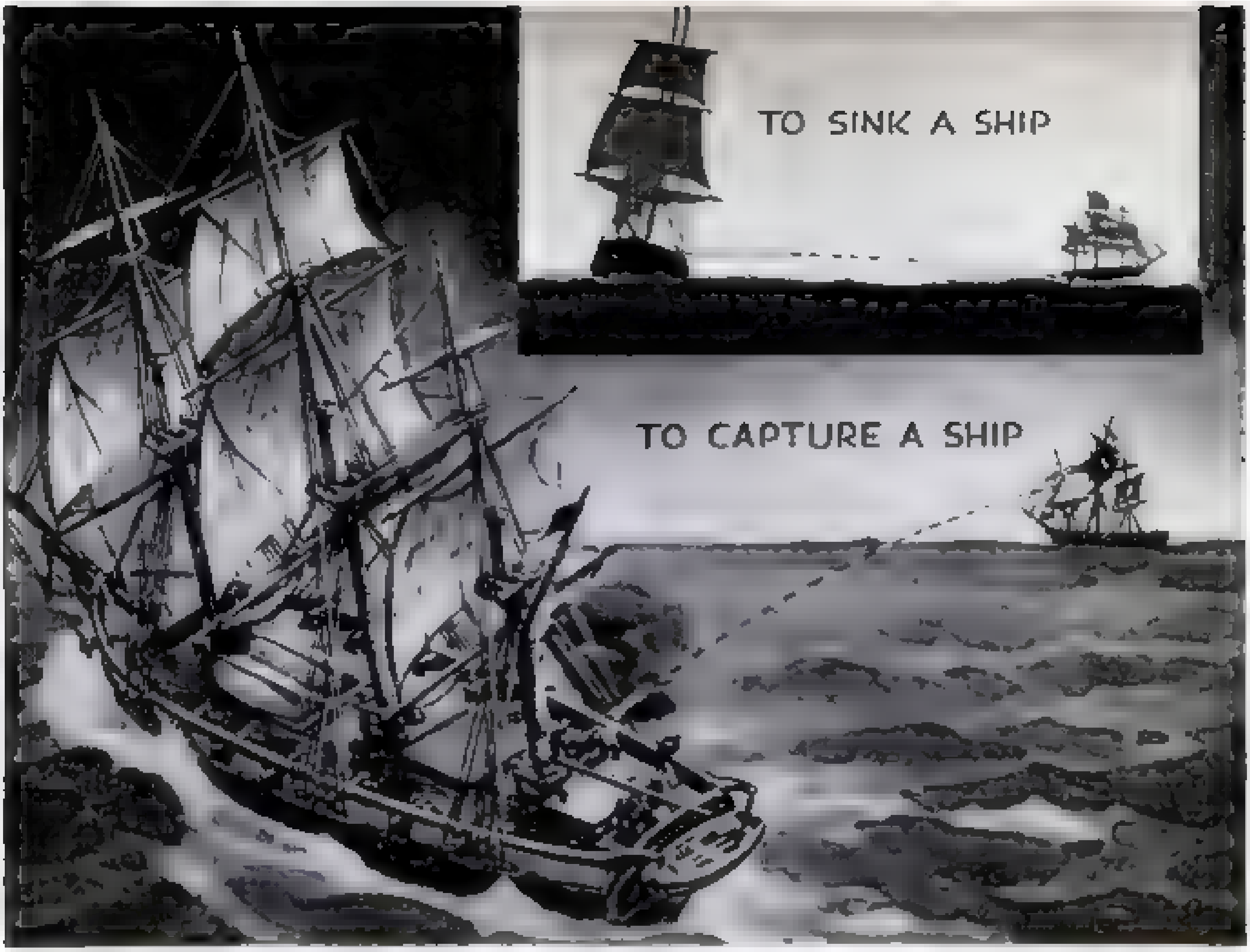
However, many cast-iron rifled guns burst, because the charge required to start the projectile on its way had to be heavier to overcome the 10-percent retarding effect of the rifling. The obvious remedy was to build guns of steel, with four times the tensile strength of cast iron. Krupp, German armament maker, tried it as early as 1851. But steel was expensive and hard to get until, in 1857, Bessemer perfected his process of making it cheaply and in quantity. After that, rifled guns improved rapidly.

Now guns and arms once more were on even terms. In 1875, the British commis-

HOW BATTLE RANGES HAVE INCREASED WITH GUN POWER



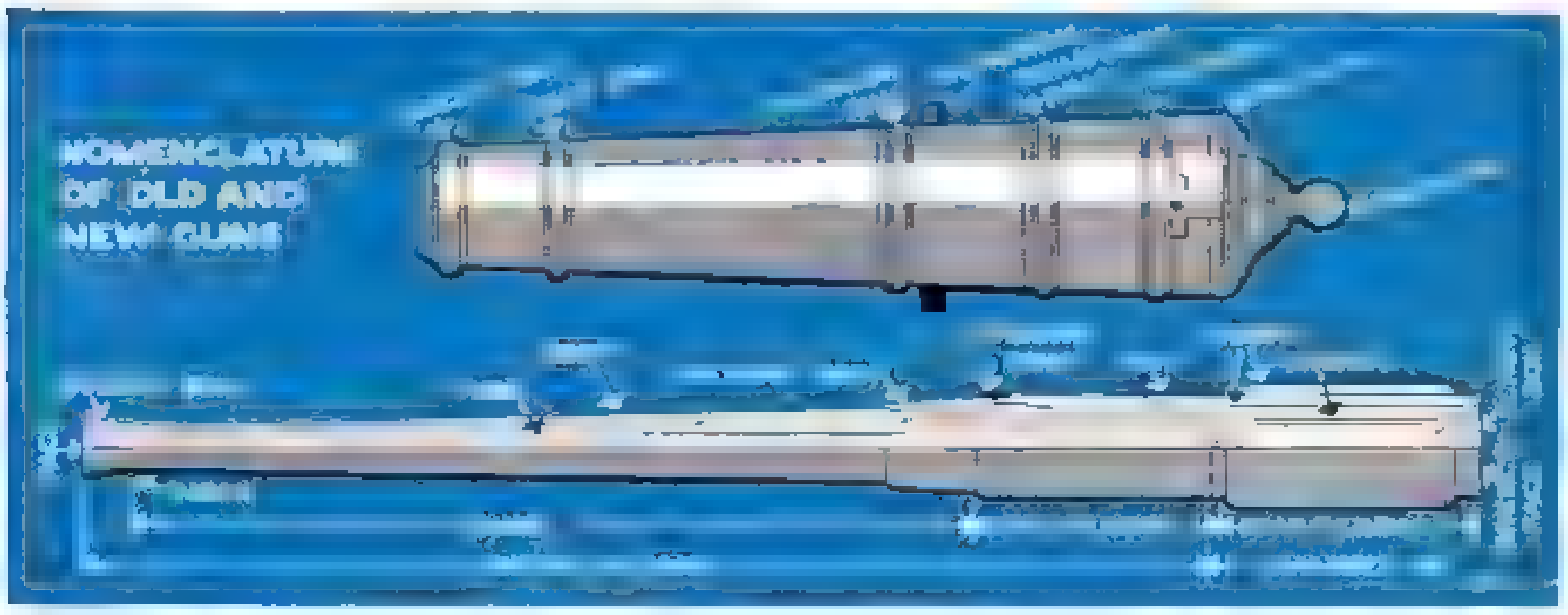
Since the day when Sir Francis Drake's little ships tossed rocks at the Spanish Armada, battle ranges at sea have lengthened as the power of the guns increased. At Manila Bay, Dewey said "You may fire when ready, Gridley" when the American squadron was about three miles from the Spaniards, and most of the real work was done at a little over a mile. At Jutland, greatest naval battle of the First World War, the opposing fleets opened fire at about 11 miles. The biggest guns today throw their one-ton armor-piercing projectiles well over 20 miles, in arcs that rise five miles above the earth. Complicated fire-control instruments must make allowance even for the earth's rotation while shell is flying



GUNNERY was more of an art than a science in the days of wooden ships. Gunners trained their pieces by squinting along the barrels and used the roll of their ships to get elevation. To hull the enemy and sink her they fired on the downroll; if they wanted to take her as a prize, they fired on the upswing to shoot away the masts and rigging

sioned the *Devastation*, considered the world's first modern warship. She was the first large seagoing fighter to dispense with sails. Her 25-ton muzzle-loading rifles were mounted in turrets protected by 14 inches of armor, and she had a 12-inch armor belt along her water line. A little later the French built a ship with 15 inches of armor. Then, in 1881, the British launched the thickest-armored ship ever built—the *Invincible*, with a 24-inch-thick armor belt and 17 inches of armor over her turrets. Her main battery numbered 16 81-ton muzzle-loading rifles—the last muzzle-loaders that were mounted on a first-class battleship.

The earlier smoothbore guns were pot-bellied because it took a lot of cast iron to withstand the chamber pressure set up by a propelling charge of fast-burning black powder. They were short-barreled, since there wasn't any use of having a long barrel in which the pressure dropped 90 percent after the cannon ball had traveled one foot; on the rest of the way to the muzzle, it was moving much faster than the gases which should have been propelling it. About 1880, slower-burning brown powder became available. Its large, perforated grains exploded progressively and built up increasing gas pressure behind the projectile. Use of this



powder reduced chamber pressures and made long barrels pay dividends in augmented muzzle velocity. Naval guns lost their potbellies and began to assume their present lean form.

Three years after the *Invincible* had been launched, the British themselves canceled her invincibility with next to the largest naval gun ever built—a 16¼-inch monster which, at a range of 1,000 yards, could send a 1,800-pound projectile through 34 inches of wrought iron. Those were dark days for the armorers, whose problem seemed hopeless—until nickel-steel plate, the first great improvement in armor plate, was introduced in Europe in 1889. In the same year our Carnegie and Bethlehem plants were producing it. The next year, they turned out even more efficient armor, face-hardened by the Harvey process.

The day of the heavily armored, big-gun ship had dawned. After letting our fleet rust from the Civil War to the mid-1880's, Congress appropriated funds for the ships that became world-famous as the White Squadron. We bought guns from England, brown powder and armor plate from Germany, and armor-piercing shell from France. Then the lawmakers wisely decreed that only materials of American make should be used in building our new Navy—a move which led to the establishment of an armament industry in the United States.

Once more the armor-makers suffered a setback. Smokeless powder, a slower-burning and more powerful propellant than brown powder, appeared in Europe and soon was in production here. By about 1890, American steel companies began forging armor-piercing shells, and we soon were making the high explosives that supplanted powder as the bursting charge in them. Our gunmakers produced 13-inch turret guns for the battleship *Oregon*.

Our new guns and ships were tested at Manila Bay and Santiago, and the United States came out of the Spanish War a world naval power. Ever since then, our guns and armor have been at least as good as those of any other nation.

In 1916 we mounted 16-inch guns on the *Maryland*, and the Japanese brought out their *Mutsu* class with 16-inch guns. The biggest British battleship guns used in World War I were of 15-inch size. Two 18-inch guns, the largest ever to go to sea, were mounted by the British upon the cruiser *Furious*. Soon, however, the ship was converted into a carrier, and the guns went to Singapore as harbor-defense weapons. Presumably, the Japs have them now.

So far as is known, the biggest guns of French, German, and Italian warships are 15-inch. Britain used 16-inch guns for the first time in her *Rodney* class of 1925; went back to 14-inch for the *King George V* class in 1939; and returned to 16-inch for her new *Lion* class.

All new American battleships, including the 35,000-ton *North Carolina* class and the 45,000-ton *Iowa* class, employ main batteries of 16-inch guns. Modern design makes them the most powerful engines of destruction that have ever been used at sea. They weigh 100 tons. Their one-ton armor-piercing projectiles travel a half mile a second. Fired at an elevation of 42 degrees, they have a range of well over 20 miles, and crash down upon armored decks from a five-mile-high arc.

Bigger guns would have more destructive power, but would impose increased difficulties in ammunition handling, and a slower rate of fire. Unless we see sensational improvements in armor, 16-inch guns will probably be the largest that will ever be used aboard a battleship.

Guns of six smaller sizes now are being built for our Navy—eight-inch for heavy cruisers; six-inch for light cruisers; five-inch dual-purpose guns for the all-five-inch-gun cruisers of the *Juneau* class, for secondary and antiaircraft batteries of the larger ships, and for our new destroyers; three-inch for DE boats, merchant ships, and various other craft; and 40-mm. Bofors-type and 20-mm. Oerlikon-type automatic antiaircraft guns for numerous classes of ships. Fourteen-inch guns still are used—and are highly effective—on many battleships, and four-inch guns (some of them adapted for antiaircraft fire) are on World War I destroyers now in service, but guns of these calibers are not being built now.

Our naval guns are of two kinds—built-up and radial-expanded.

The 16-inch, 14-inch, and 12-inch guns used in the turrets of our battleships all are of the built-up type. Most of them are built of five layers of metal—liner, tube, jacket, and hoops. Initial bore compression is obtained by shrinkage; then the jacket and hoops are heated and shrunk into place over the tube. Bag ammunition is used in these guns. First the projectile is loaded; then the propelling charge, contained in one or more silk bags, each with an ignition charge in its base, is loaded behind it. The breech mechanism is a rotating block with an interrupted-screw plug which may be entered or withdrawn in one motion and locked or unlocked by a part turn. A safety device prevents the firing of the gun until the breech is closed. Combination primers are used, but normally firing is by electricity.

In ships built since 1916, guns from eight-inch to 16-inch caliber have been mounted in three-gun turrets. A turret of a battle-

IMPROVEMENTS IN ARMOR PLATE

Rear Admiral W. H. P. Blandy, Chief of the Bureau of Ordnance, and Capt. I. D. Hedrich inspect the damage done to a sample of armor plate by a six-inch shell. Drawings at right show how, as armor improves, less thickness is required to stop a projectile of given weight and power

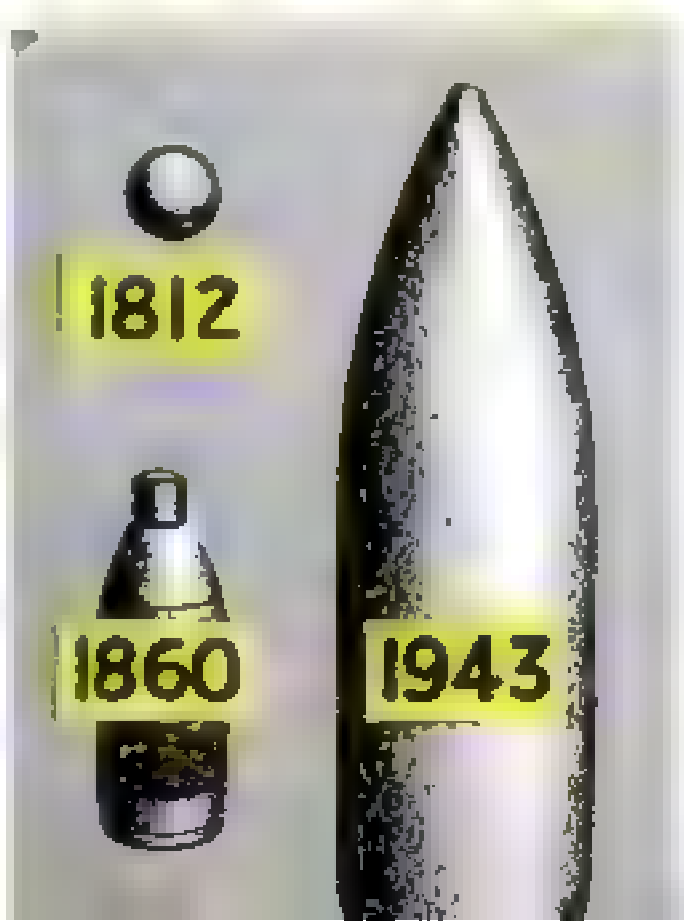
ship of the *Iowa* class weighs as much as a destroyer. The turret is built in three parts—foundation, barbette, and turret proper. The turret foundation is a cylindrical structure of heavy girders and beams built into the structure of the ship; it supports a circular track carrying rollers on which the turret rotates. The barbette is a stationary cylinder of heavy armor, which surrounds the turret foundation from the ship's lowest protective deck up to the armor skirt secured to the turret. The turret proper is a heavily armored, boxlike structure which rotates, and in which the guns are mounted; in it also are the power rammers with which the guns are loaded.

Guns of eight-inch and smaller caliber are built by the radial expansion process. Our eight-inch and six-inch guns are composed of a tube and a shrunk-on jacket which extends halfway from the breech to the muzzle. The eight-inch and many of the six-inch guns are mounted in three-gun turrets, have breech and firing mechanisms of the same types as the larger turret guns, and use bag ammunition.

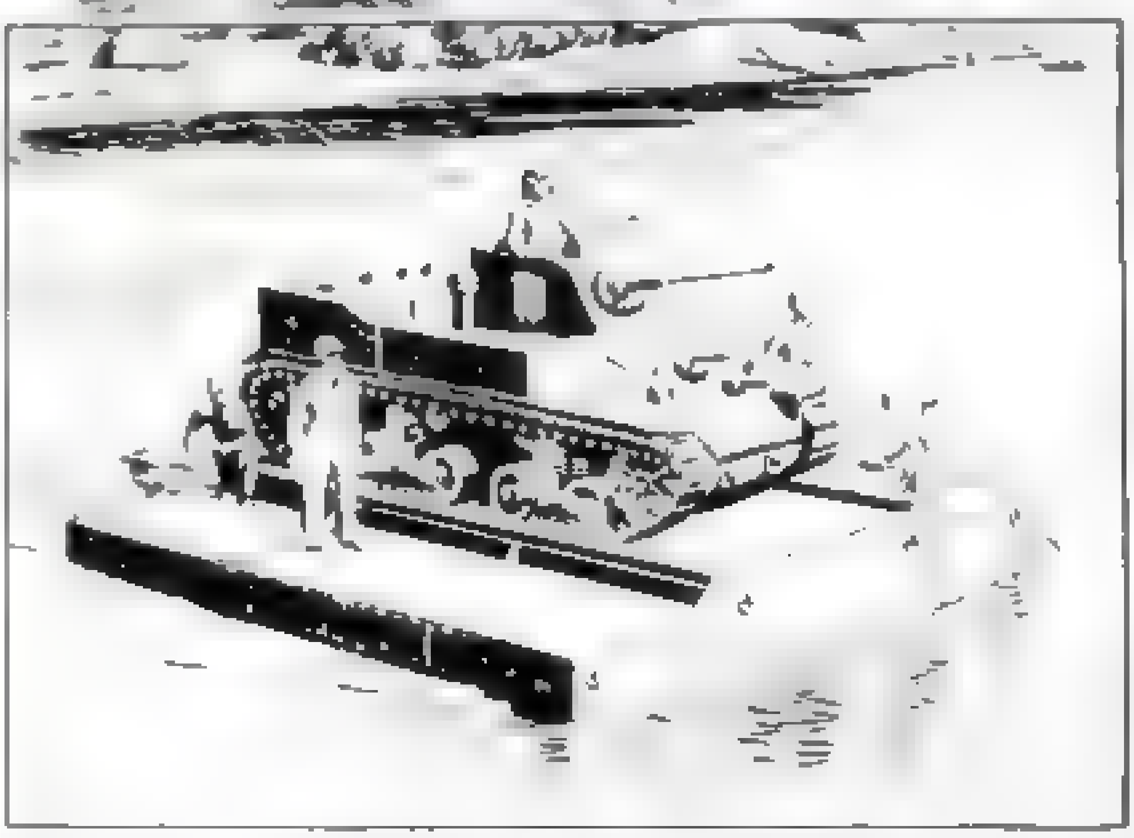
Since 1898 all navies have used Krupp-process armor, face-hardened to break up projectiles, for water-line belts, barbettes, and turret sides. It has been greatly improved by American makers in recent years. For horizontal protection our Navy uses homogeneous plate, which tends to "dish" without cracking when it is exposed to oblique hits. Most modern battleships have a protective deck six inches or more thick over their vital parts, and their turret tops are as heavy. Our battleships generally have been more heavily armored than any other navy's ships of like size. The new ones are protected by vertical armor belts over one foot thick—how much, Japan would like to know.

FROM CANNON BALL TO ONE-TON SHELL

First missiles were round, solid shot. Explosive shells came in 1822. Rifling gave us the elongated projectile



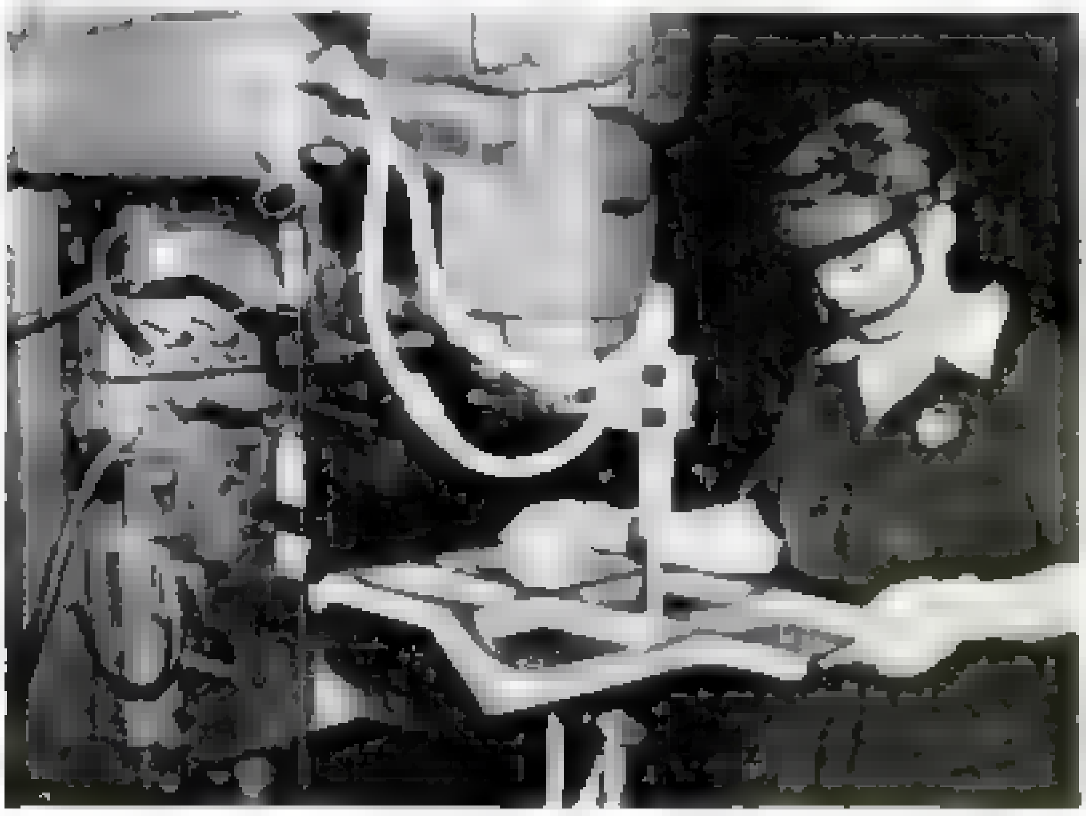
Wheeled Pontons Give Fast, Safe River Crossings



SPEEDIER, safer river crossings by our troops are promised by a trailer ponton bridge invented by Andrew Jackson Higgins, New Orleans builder of the famous PT boat. The bridge consists of a string of wheeled barges that can be hauled overland. At a stream's edge, the lead barge is hitched to a cable reel carried by an amphibian tank which swims the stream and reels in the cable, drawing the bridge across. When the bridge is in position, engineer troops swing overside hinged sections folded across the barges, providing an eight-foot driveway and two four-foot walkways. Folding end plates "marry" the barges. A single ponton unit powered by an outboard motor can be used as a ferry to transport mechanized equipment and men.

TROOP SLEEPERS, triple-decker Pullman cars designed for transportation of service men, are coming off the assembly lines of the Pullman Company. The first of the 1,200 cars in production, shown in the photos above, illustrates the novel arrangement of six-man compartments along one side of the car with a corridor on the other side. Top berths are permanently fixed; seats form the bottom berths, and seat backs swing up to form the middle tier. Doors are in the middle of the car, as seen at the upper right. Each car will accommodate 30 men with their equipment.

ZERO WELDING, a technique developed by the automotive industry, is saving precious man-hours in the production of warplanes. By applying refrigeration to the electrodes of arc-welding tools, it eliminates the need for frequent stops to clean the welding points. In the welding of aluminum-alloy sheets, too, the lowered temperature reduces the tendency to buckle. Refrigeration devices pull the electrode temperatures down as low as -85 degrees Fahrenheit.



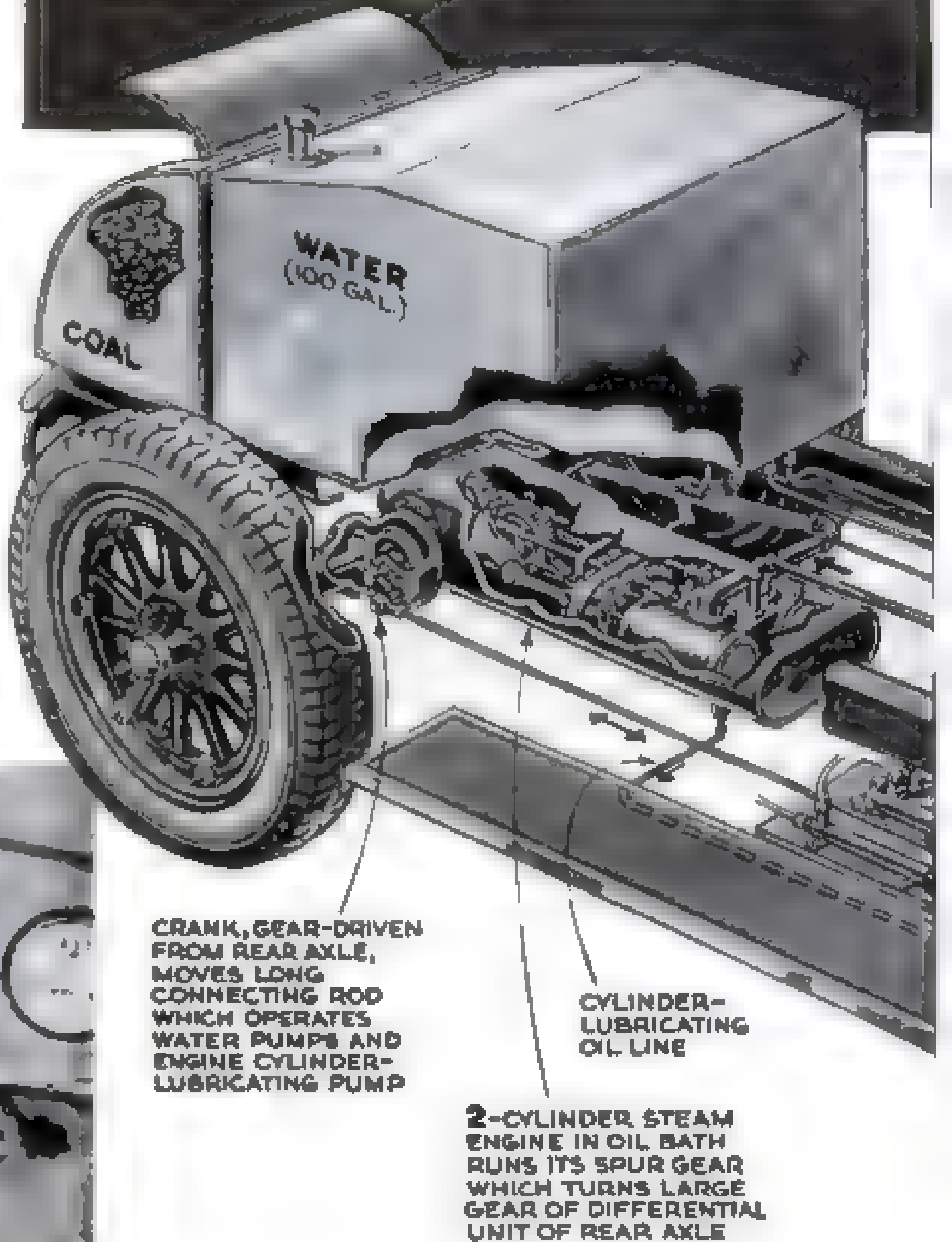
ANGLE FINDER. Determining the angle of elevation of a plane above the horizon is an easy matter now with the Polaroid-made instrument shown above. When the user trains it on a plane, a graduated scale appears in the field of vision. No matter how fast the aircraft climbs or dives, the scale shifts to give elevation in degrees.

The Coal Bin Is His Filling Station

CHUGGING along the highway at a rapid pace, with smoke billowing from its funnel and the glow of hot embers lighting the road underneath, this gasless buggy answers, for one man at least, the problem of modern wartime gasoline rationing. It travels along on coal, 200 pounds of which—a 175-mile supply—is carried in bunkers in what used to be the trunk of an old club-type coupe and the kerosene tank of a steamer.

This is a converted job—from a 1922 Stanley steamer and an old Buick body. It was made into a coal burner by the installation of an advanced type of water-tube boiler in a firebrick-lined firebox equipped with a coal-burning grate. Stoking can't be done on the run since the driver, or his assistant, must dismount, get coal from the rear of the car, and put it into the furnace at the front.

The conversion was the work of C. C. Mershon, a grate maker, of Philadelphia.

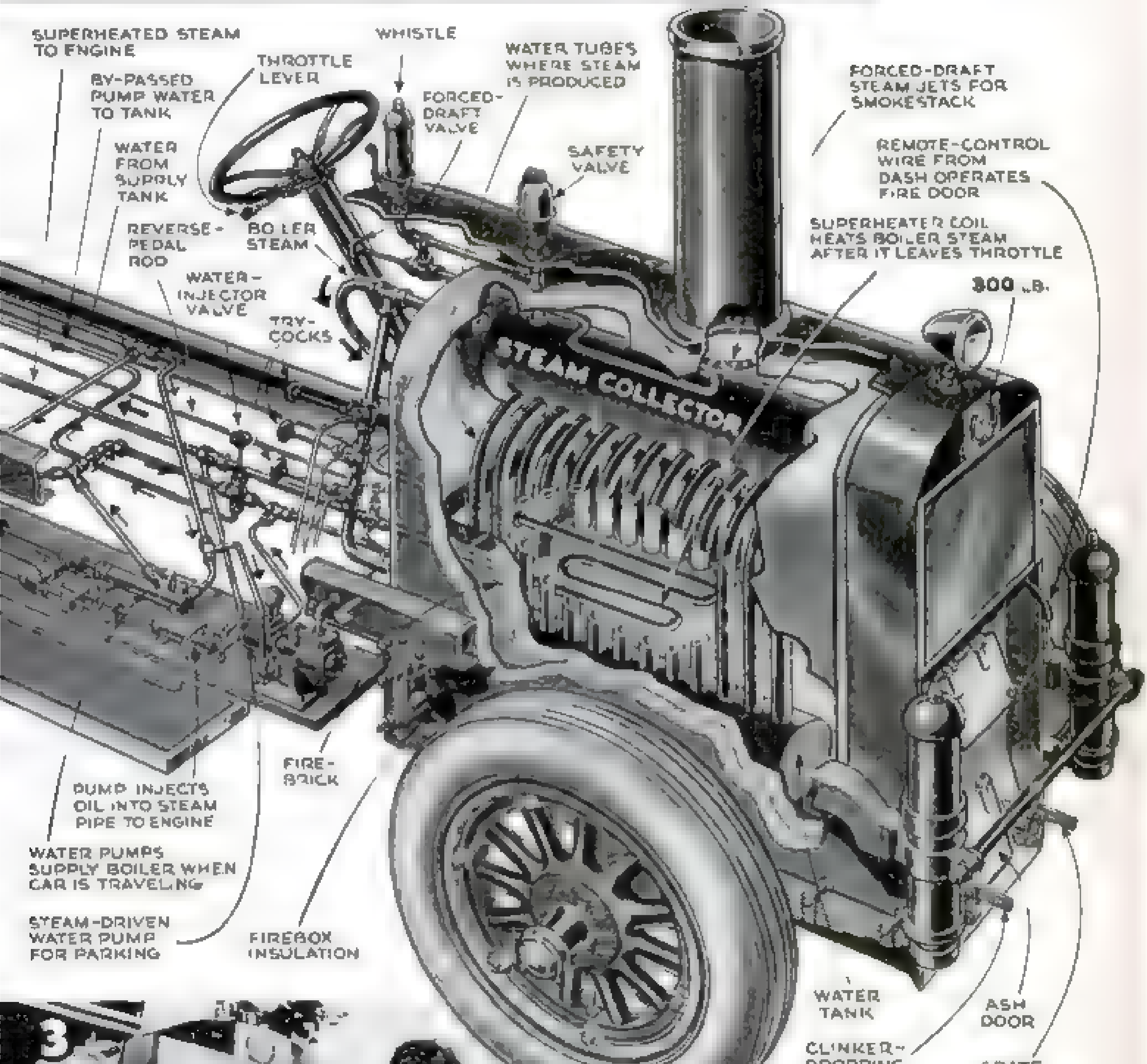


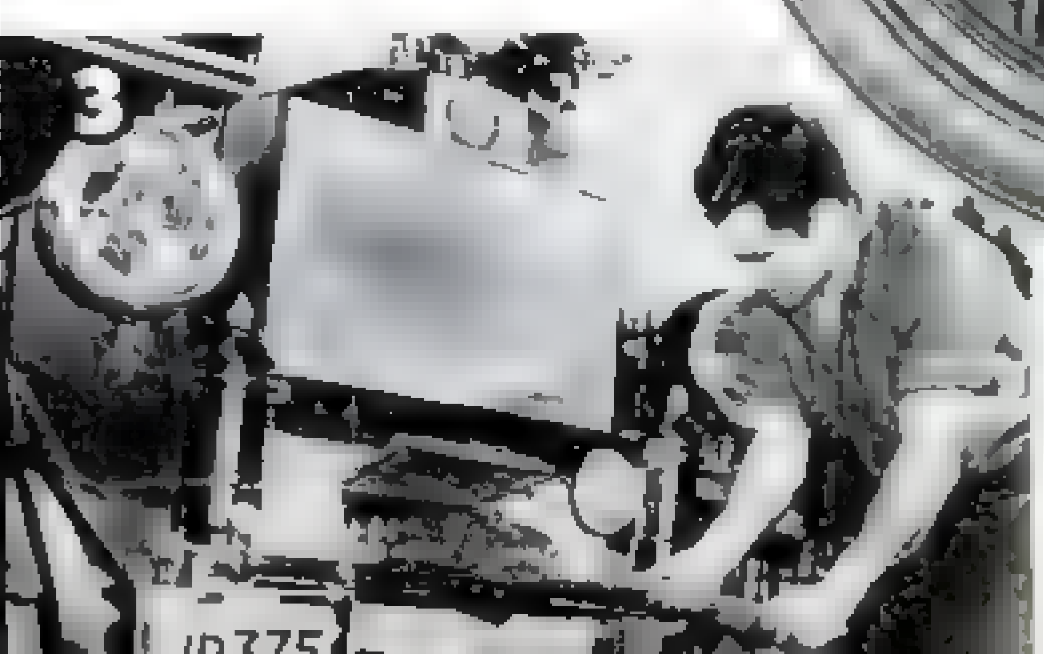
"Standard" equipment on the dashboard of this coal-burning steam car includes a steam gauge, a whistle, and a lever controlling the fire door

Drawing by

STEWART ROUSE

Standing beside a 1942-model gasoline-powered car, Mershon's steamer may look a little old-fashioned but the owner doesn't have to count any coupons. With 200 pounds of coal it will run 175 miles





To get up enough steam for a Sunday joy ride past the homes of his gas-hungry neighbors, Mershon begins by (1) shaking down the special grate—of which he is the inventor and manufacturer. He then takes a shovelful of coal (2) from an old kerosene tank, which serves as one of the car's two coal bunkers, and (3) happily tosses it into the firebox in front

Modern Infantry Rides

Getting over the ground at 25 miles an hour, our motorized divisions strike swiftly and suddenly. They have proved the soundness of our peacetime military planning.

By JOHN H. WALKER

MOTORIZED infantry, a new weapon in the American arsenal, has now met the final test of major battle, and many military observers believe that these high-wheeling foot soldiers will deal the decisive and finishing blows in the greatest war of world history.

Fast infantry is a relatively new concept in war. From the dim days of Cyrus the Great to the first World War, the fate of battles and nations was decided, in the main, by the shock of troops who marched and maneuvered at the classical pace of three miles an hour.

The gasoline engine has changed all that. A modern motorized infantry division can move 10 miles per hour over poor roads, 15 over secondary roads, and 20 or 25 on good highways. In terms of battle strategy, this means that troops who used to move to the battle front at 15 to 25 miles a day can now approach action at 100 to 150 miles a day. The whole pace of a military operation develops about six times faster than in the past.

This speed-up has greatly increased the advantage of the force that can seize and hold the initiative. It has made this a truly offensive war, as contrasted with the grinding defensive struggle which the trench and machine gun made of World War I.

Motorization also has put the element of deception back into large-scale war by making possible the rapid grouping of forces for an attack at an enemy weak point. In World War I, the opposing commanders had to depend almost entirely on railroads, and it took weeks to pile up the overpowering quantity of supplies and troops needed to mount an offensive.

Motorized infantry has not cut so spectacular a figure in the war reports as its mechanized partner, the armored force, yet its basic function is fully as important as that of the tank formations. It nails down and exploits the gains that the tanks batter out; to use an analogy with football, the tank first opens a hole in the enemy line, and then the motorized division carries the ball.

There is a practical reason for this. The armored division, preceded by infiltrating infantry, is formidable in attack, but has relatively little defensive strength or holding power. It is never more vulnerable than at the moment when its forward lunge has been halted, its headlong momentum spent. That is when the motorized division becomes especially valuable. Following the armored striking force through the gap in the enemy's formations, the fast infantry occupies roads, crossings, bridges, towns, and other strategic points. Then it fans out, rolling back the flanks of the gap or curving back to attack from the rear.

Moreover, if the initial break-through succeeds in disrupting the enemy resistance, the main job of pursuit and destruction falls to the motorized divisions. For this task they have the right combination of great mobility plus great combat strength and fire power. They can hit hard to break up any reorganized center of resistance, or, if the enemy develops a strong counterattack, they can dig in and hold until the armored force and other reinforcements are brought up to strike again. This process, in which units of an army take turns in striking and supporting each other, is called "leapfrogging."

The motorized division's function of pursuit after a break-through is of great importance. Correspondents and commentators who have studied the massive fighting in Russia since 1941 are inclined to believe that both the Nazis and the Russians missed chances to win crushing and decisive victories in the first year by not having enough motorized divisions to exploit initial successes. Both armies inflicted heavy defeats on the enemy during their separate offensives; neither side had enough fast infantry to prevent the other from carrying out an orderly retreat.

There is nothing essentially mysterious or startling in the organization of a motorized infantry outfit. It is simply an infantry division permanently equipped with its own motor transportation. The men ride their vehicles to the zone of action, then dismount and fight on foot as any other infantrymen would.

The idea was tried out on a limited scale during World War I. Wherever possible, troops going up to the front were hauled by truck; no soldier who rode very far in a 1918-model camion will ever forget the experience. But the number of trucks and lorries that were available always was rela-

to Battle on Wheels...

...and Fights on Its Feet

AIR TRANSPORT has given the infantry wings, stepping up the traditional three-mile-an-hour foot-slogging pace of troop movements to a couple of hundred miles an hour. MacArthur's heavy blows against the Japs in New Guinea were aided greatly by this modern way of moving the man with the gun

tively small. Major movements of troops and equipment were pretty well confined to the existing railway nets.

The modern motorized division, however, rolls along in style, riding in some 3,000 vehicles of all types, ranging from the fast scouting motorcycle to the heavy cargo truck. Such a division will include about 12,000 men. It is slightly smaller than a standard triangular infantry division, but has greater fire power, mainly because it is more lavishly equipped with automatic weapons.

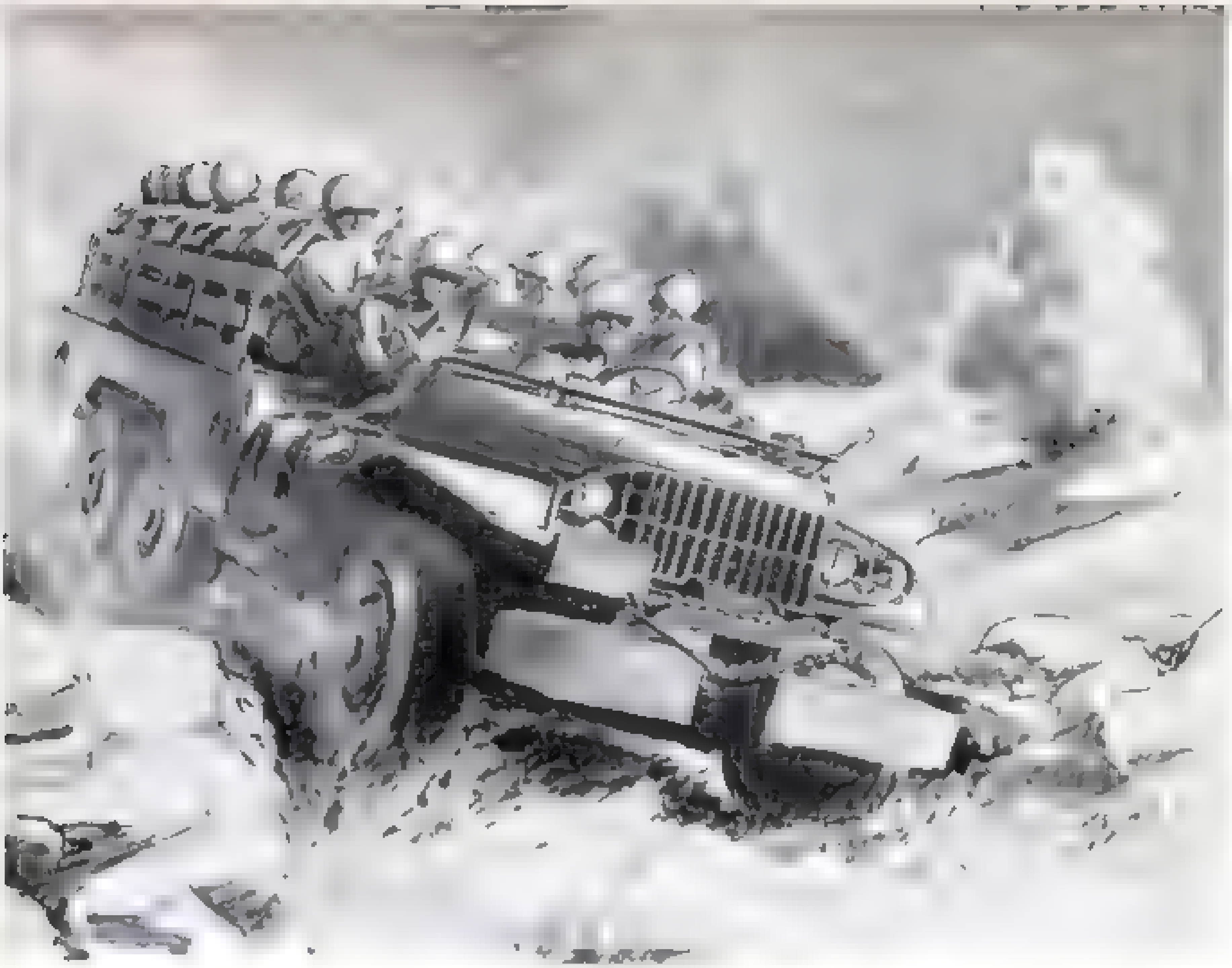
The U. S. motorized division has jeeps, half-ton trucks, three-quarter-ton heavy-weapons carriers, and 2½-ton cargo trucks and personnel carriers as its basic vehicles. The omnipresent jeep is the all-purpose car, serving as anything from reconnaissance car to ammunition carrier. The handy three-quarter-ton is now being standardized as the Army's medium truck. It is squat and strong in appearance, looking something like a burly, overgrown jeep, and its low-slung look has won it the nickname of "Toad"—a term believed to have originated among the men of the Sixth U. S. Motorized Division.

Aside from these basic cars the division has many specialized vehicles, including armored scout cars, self-propelled artillery, mobile repair shops, command cars, Medical and Signal Corps cars. The infantrymen themselves ride the 2½-tons, 20 of them to a truck with their full field equipment on board.

Enemy aircraft are extremely dangerous to a moving truck column, of course, and a sharp watch is kept. Every other truck in the moving line carries a .50 caliber machine gun on an antiaircraft mount.

In normal circumstances the cars are required to keep a considerable interval between them on the road, to lessen the damage from a bomb or shell hit. As a result, a division may stretch from 20 to 30 miles along a road, and may take two hours or more to pass. Such an outfit on the move is an impressive demonstration of flexible, controlled power rolling by. In dry weather the cars kick up plenty of dust, and each succeeding truck seems to loom up out of a mist and lumber by, while the troops inside stare out, some grinning and curious, some intent and serious.

The complicated movement of men and machines goes on with remarkably little confusion. Its marching orders have been drawn with railway-timetable precision, and every unit must move by at the scheduled time. The division has its own military po-



NEW TROOP CARRIER. Sixteen infantrymen with full equipment can ride the new Dodge-built six-wheel-drive cargo and troop carrier. High-flotation tires enable it to plow through mud craters or negotiate desert sands. Parts are about 96-percent interchangeable with those of four-wheel-drives

lice company, primarily to handle traffic problems at tough places along the road, and road guides with painted signs and arrows indicate the correct turns at intersections to save even the little loss of time that might be occasioned if the drivers had to slow down slightly for directions.

Those traffic MP's are one example of special troops attached to the division either permanently or for temporary service. There are many others. The American motorized division is by no means a rigid organization, and the Army has been consistently willing to experiment and reshuffle the outfit to build up its combat strength. The exact tables of organization of the new-type division have not been published, but the general character of such a division is well known.

Basic fighting units in a typical division are three regiments of infantry and four battalions of artillery. Three of these are light artillery (105-millimeter gun-howitzers) designed to support the three infantry regiments. The fourth battalion usually functions as divisional heavy artillery, and is equipped with 155-mm. howitzers.

The motorized division is well equipped for reconnaissance, being assigned a full squadron of mechanized cavalry, as contrasted with the single troop that is allotted to a regular triangular infantry division.

Other components of the motorized organization include one or two battalions of engineers, medical and quartermaster battalions, signal company, and ordnance units. Special troops may be added for particular missions—tanks or tank destroyers, for example, or extra engineers trained specially for river crossings or the neutralization of mine fields.

The division, in any case, is not regarded as a rigid, unalterable organization, and does not try to fight that way. Its combat operations rather are based on the principle of the combat team. The entire trend of modern war is toward the creation of these teams—special task forces flexibly organized and built up to whatever strength appears to be needed for the specific mission in hand.

Combat teams can be of any size, from a squad to an army. In normal divisional operations, however, the commander (usually a major general) would be likely to arrange his force in three combat teams. Each of these would be built around a regiment of infantry and a battalion of light artillery.

Reconnaissance, engineers, tank units, and other forces are added as they are needed. The infantry regiment, incidentally, provides an extra punch for the team with its own

cannon company, which functions as an integral part of the regiment. The main self-propelled weapons are the 75-mm. gun mounted on a half-track vehicle and the newer 105-mm. on a full-track chassis like that of a medium tank. These 105's, which gave the Germans such a nasty surprise when they were first used in North Africa, got the nickname of "Priests" from the British troops because of the pulpitlike appearance of their antiaircraft machine-gun turrets.

The infantry regiment's colonel is the logical commander of a combat team of this size, and in the course of a battle he may often find it advisable to assign smaller teams within his own force to carry out particular tasks. To a large degree a modern battle, even on the greatest scale, consists of a vast complex of relatively small actions by teams.

An enemy outfit which tries to meet this attack by the old technique of stringing out along a wide front soon finds itself being chewed up and disrupted by the hard-hitting teams, which pick their own points of attack and always have great local superiority at the places they strike.

When the division moves up for combat, its reconnaissance force normally leads the way. However, as the mechanized cavalrymen are likely to get out 50 miles or more ahead, the division supplements them with a close reconnaissance of its own, mainly carried out by infantrymen with rifles and machine guns in jeeps.

The actual width of the divisional front varies widely according to the terrain, the nature of the operation, and the size of the enemy force. It can be as narrow as a few hundred yards or as wide as several miles, especially if two opposing forces are trying to outflank each other in open country. A motorized division hates to depend on a single road; two roads is the minimum it likes to move on, and the more alternative routes it finds available, the better use it can make of its mobility in maneuver.

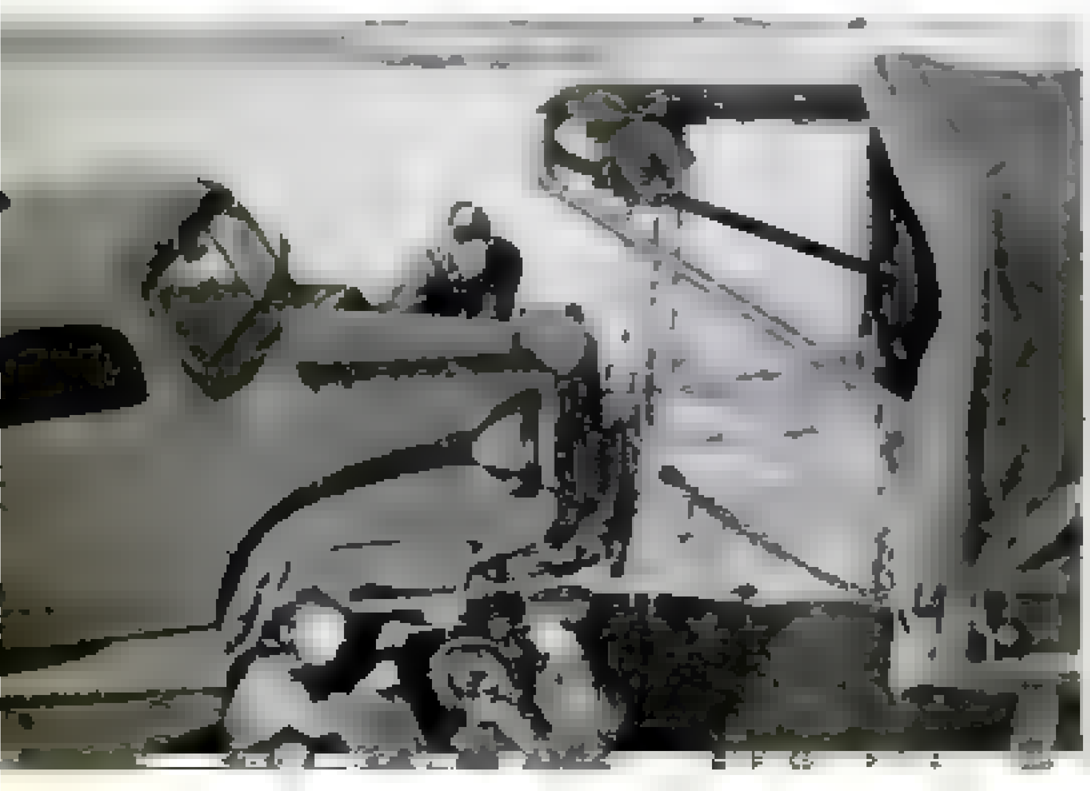
Military men have sharply divergent opinions on one of the most important factors in the tactical employment of motorized infantry—the point at which the men should be dismounted for action. One school of thought holds that this should be done when the vehicles come within range of enemy light artillery, while another believes that the dismounting is not necessary until the trucks come within range of effective small-arms fire.

The first range suggested would be 10,000 yards, which seems pretty far back. And the second would be 2,000 yards, which may or may not be too close. On the whole, the German example in the first two years of the war seems to indicate that the speed and mobility gained justify the risk in bringing the vehicles extremely close to the action. The Nazis even worked out a technique under which special infantry shock troops—*panzerjaegers*—were attached to the armored forces. Their task was to mop up scattered enemy resistance in the gap made by the tank attack, so that the motorized infantry could be rushed through and dismounted in position to strike the enemy's main body from the rear.

The normal pattern of a modern attack most often proceeds with reconnaissance in the lead, then the armored striking force, then the motorized divisions to exploit the attack, and finally the regular infantry to occupy the territory and anchor the new position against a counterattack. (In some situations, however, the entire attack may be led by special shock infantry and engineers trained to knock out fortifications and dig up mine fields.)

When an engagement is being prepared, the division must find the best possible concealment for its (Continued on page 218)

MAINTENANCE of the huge fleet is simplified by limiting vehicles to a few general types in which the repair parts are interchangeable. Here two soldiers in overalls are fixing up the front end of a truck while another checks on its engine

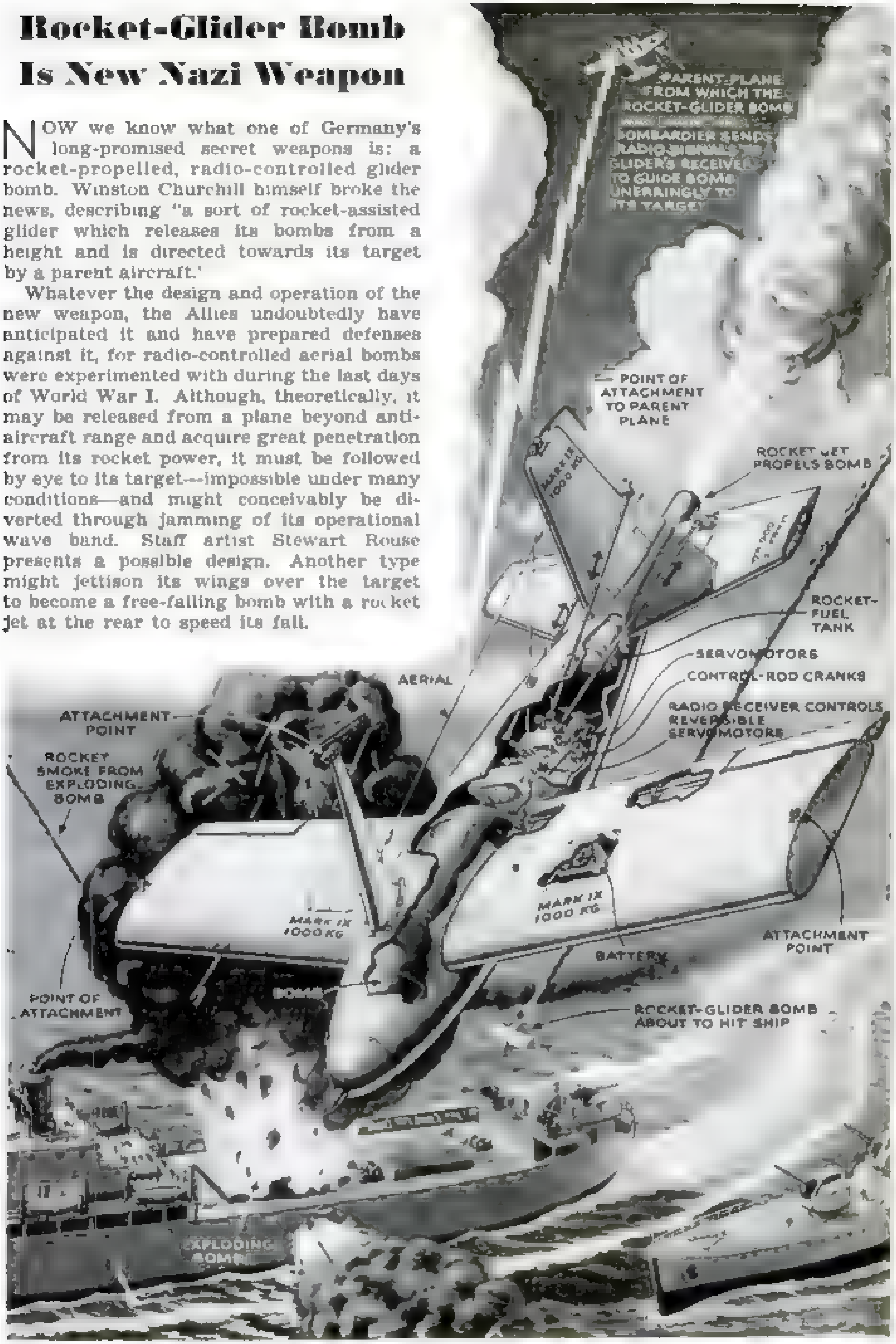


CHOW keeps up with the fast-moving infantry. Army cooks in mobile kitchens serve freshly cooked, hot food. In action, however, the men may have to live for days on emergency rations

Rocket-Glider Bomb Is New Nazi Weapon

NOW we know what one of Germany's long-promised secret weapons is: a rocket-propelled, radio-controlled glider bomb. Winston Churchill himself broke the news, describing "a sort of rocket-assisted glider which releases its bombs from a height and is directed towards its target by a parent aircraft."

Whatever the design and operation of the new weapon, the Allies undoubtedly have anticipated it and have prepared defenses against it, for radio-controlled aerial bombs were experimented with during the last days of World War I. Although, theoretically, it may be released from a plane beyond anti-aircraft range and acquire great penetration from its rocket power, it must be followed by eye to its target—impossible under many conditions—and might conceivably be diverted through jamming of its operational wave band. Staff artist Stewart Rouse presents a possible design. Another type might jettison its wings over the target to become a free-falling bomb with a rocket jet at the rear to speed its fall.



How the Bazooka Team Stops 'Em

Photographs by William W. Morris

THERE'S one thrill no soldier will ever forget—the first time he fires a bazooka. This weapon (P.S.M., July '43, p. 110), so long kept hush-hush, is unlike anything else in warfare.

Normally, two soldiers form a bazooka team, although one man can fire it unaided in an emergency. The firer carries, aims, and fires the rocket launcher, as the tube is technically called. The loader carries the projectile and loads the weapon.

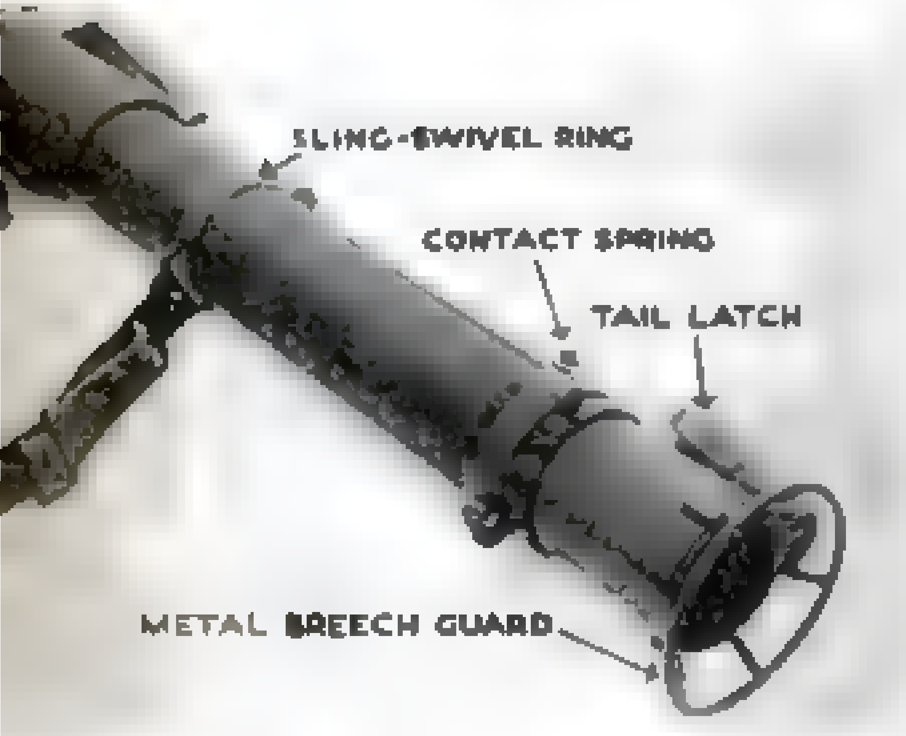
First, the firer tests the electric-battery circuit by pressing the trigger several times and noting if a miniature bulb on the stock flashes on and off

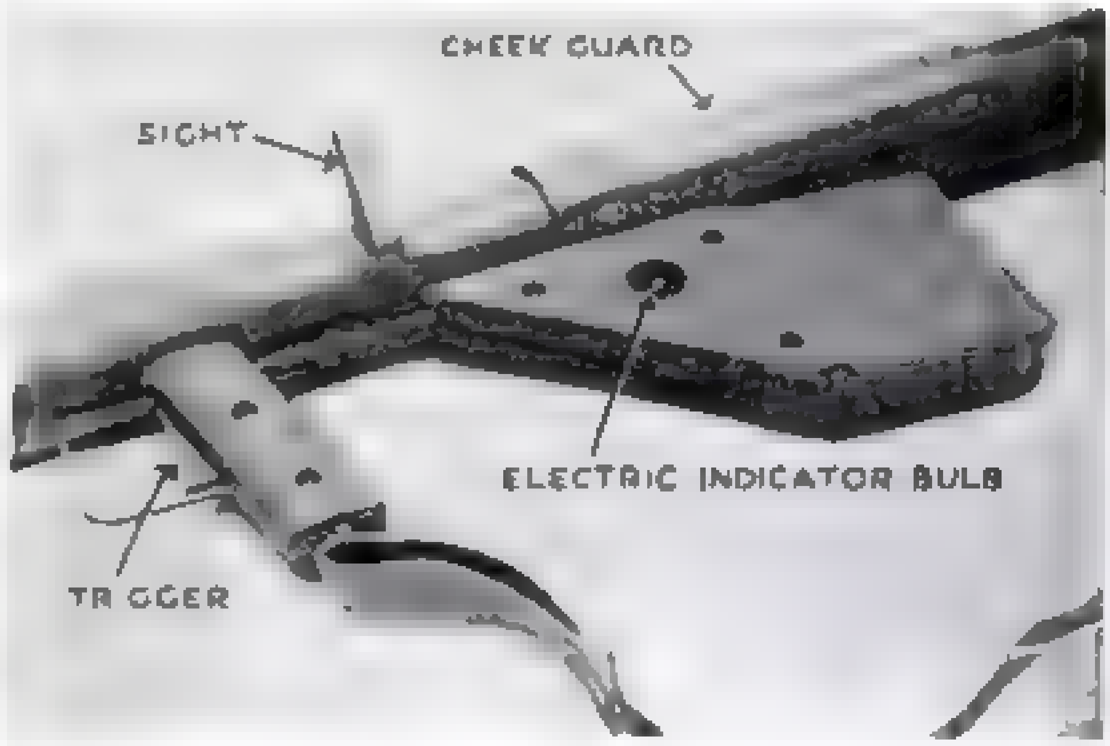
To load, the loader grasps a rocket by its tail and inserts its head into the tube. Next, he removes the safety pin from the fuse. Pushing the missile into the tube until the tail latch at the breech engages a notch in the fins, he pulls one end of the contact wire off the tail and inserts it in the contact spring on top of the tube near the breech. That done, he snaps: "Ready to fire!"

The firer takes aim and presses the trigger. This closes the electric circuit and sets off an igniter inside the rocket. The propelling charge lets go with a blast that shoots from the rear end of the tube. This high-speed jet of gas, which is generated by the progressive burning of the propelling charge in the projectile itself, is what launches the rocket and carries it to its target. There is no recoil, but the loader must keep well to one side of the open breech.

In the streamlined head of the rocket is a high explosive. It is this that does the damage. The effect of the explosion almost defies description. It will knock out a tank with a single shot, shatter concrete pill-

JUST A FEW SIMPLE PARTS MAKE THE ROCKET LAUNCHER





STEPS IN LOADING THE ROCKET, WHICH PROPELS ITSELF

Grasping the rocket projectile by its tail, the loader raises the tail latch and inserts the rocket head. The head carries the high-explosive charge; the elongated tube, the propelling charge

When the head has entered the tube, but not before, he removes the safety pin from the fuse of the projectile. The entire missile is about two feet long; the fins act like feathers on an arrow

Next, the loader slips the projectile into the bazooka until the tail latch engages a notch in the edge of a fin

THE DEADLY TUBE IS HELD LIKE A GUN—STANDING, KNEELING, SITTING, OR PRONE

The bazooka may be fired from a standing, kneeling, sitting, or prone position. The loader adapts himself to the position of the firer, as in these photos. Basically, the bazooka is a lightweight metal tube open at both ends, slightly more than four feet long, a little less than three inches in diameter. At about its middle, the tube is supported by a wooden stock, which the firer places against his shoulder. Ahead of this is the foregrip, which he grasps with both hands as he takes aim. Dr. Robert H. Goddard, experimenting with rocket weapons in World War I, developed a launching device so light that a soldier could hold it. This was perhaps the ancestor of our fabulous bazooka

boxes, and blast down thick stone walls. In Sicily, bazooka-armed soldiers destroyed six German Mark VI tanks their first morning in action.

If for any reason the bazooka is not fired after being loaded, the loader removes the contact wire from the spring, raises the tail latch, withdraws the rocket far enough to reinsert the safety pin, then completes the withdrawal.

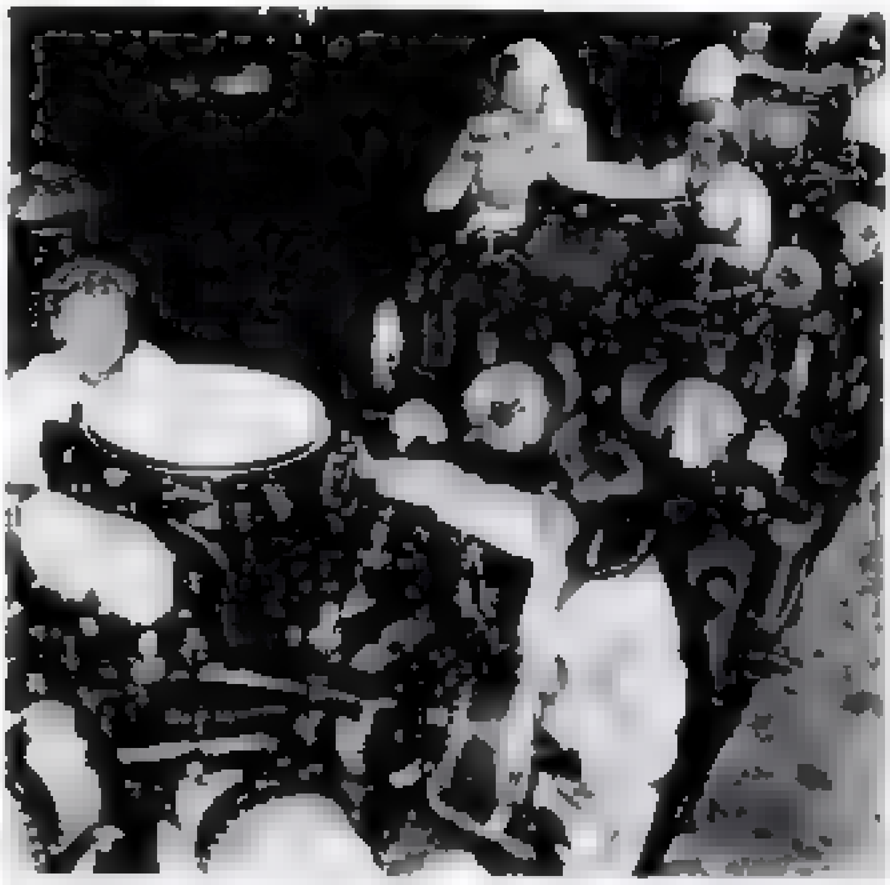
By developing the bazooka, our Army Ordnance Department modernized an old and almost forgotten weapon—the artillery rocket (P.S.M., July '43, p. 50). Best of the old artillery rockets was the Congreve, invented about 1800. The British fleet used it against Fort McHenry in Baltimore Harbor, and it was immortalized in the line of "The Star-Spangled Banner" that describes "the rockets' red glare." Resemblance to comedian Bob Burns's famous "bazooka" inspired the modern launcher's name.

TO THE TARGET, THEN EXPLODES WITH DEVASTATING FORCE

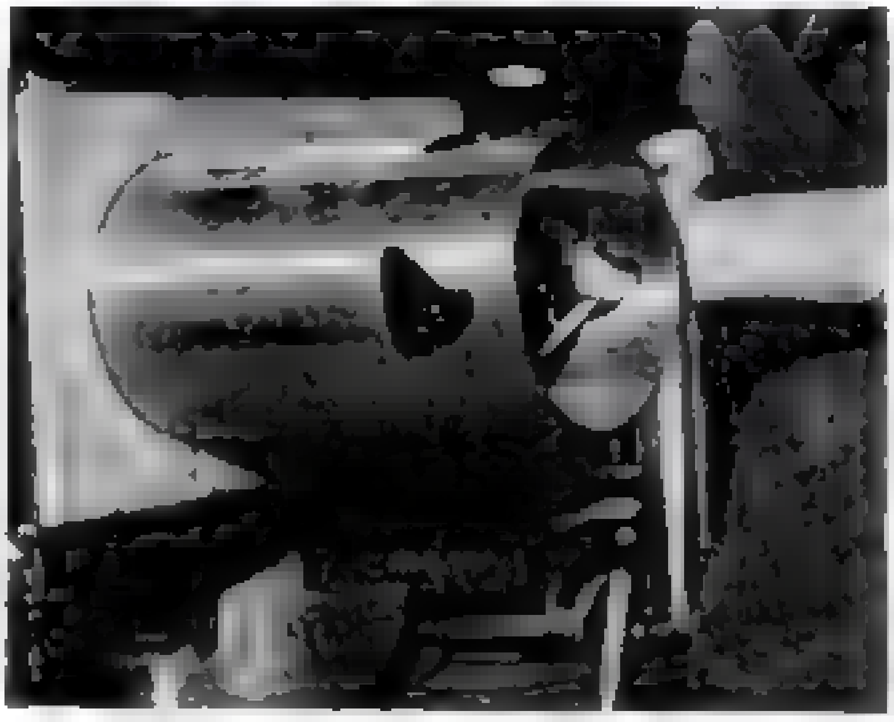
After pulling one end of the contact wire off the fin, he inserts it in the contact spring of the bazooka. Right, the blast

Britain Builds Sleeve-Valve Motors for Her New Aircraft

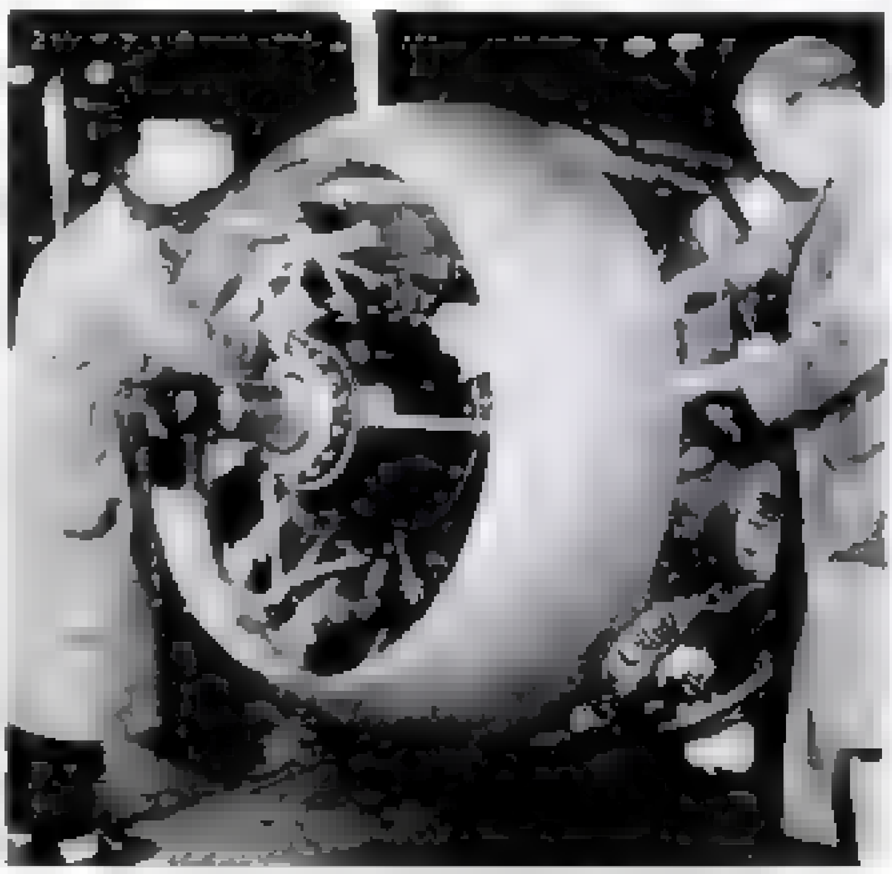
The induction system of a British double-bank 14-cylinder Hercules engine is shown being assembled



Women workers are best for these finely made motors



Phrasing a sleeve valve calls for delicate fingers



Exhaust-ring assembly. A hemispherical cylinder top reduces detonation, increases ratio of compression

SLEEVE-VALVE motors, which have been found to be more efficient and economical than the poppet-valve type used on ordinary aircraft, and less vulnerable because they have no gear outside the cylinders, are now standard equipment on Britain's Beaufort bombers and alternative equipment on her Short Stirling bombers. Other features which give the new motor preference over the old are that the top of the combustion space can be made hemispherical which, with a central spark plug, reduces detonation; that equal cooling is permitted over all; and that with a given fuel higher compression can be achieved.

British manufacturers have found that fitting the sleeve in the cylinder and "phrasing" the sleeve (finishing the ports to shape) are delicate operations best performed by "lady fingers"—which explains the wide use of women workers in the production of these 1,425-horsepower, 9 and 14-cylinder motors. Because they need no top overhauling between the times when they are completely overhauled, the motors are most practical under conditions where airports are remote.

British methods of manufacture, which include much hand work, make it comparatively easy to produce these finely made motors. But if the Napier "Sabre"—a new British motor of sleeve-valve design, claimed to be the most efficient yet—is to be made in the United States, it will provide a stimulating challenge to the accuracy of American high-speed, mass-production methods.

Grumman-built, the Hellcat (F6F) is the Navy's latest one-place fighter, successor to Wildcat (F4F)

How the Hellcat Got That Way

It was born in the heat of battle, fathered by fighter pilots of the Navy who needed more power, speed, and climb.

By C. B. COLBY*

Photographs by ROBERT F. SMITH

THE lanky fighter pilot pulled the jack on his throat microphone and disgustedly slammed back the hatch of his Grumman F4F Wildcat. As he hoisted his frame over the side and dropped to the wing, he muttered, "Damn it, it's like swatting mosquitoes with a club. If you hit him it's a mess, but the trick is to hit the blank-blank thing!"

That, in the words of a fighter pilot, just about summed up the heartbreaking situation after the Japs introduced their famous Zero fighter. These faster and more acrobatic, although fragile, fighters stunned the American pilots with their flashing hit-and-run tactics and dazzling maneuverability.

Although bewildered, the stubborn Navy flyers went into a huddle to devise ways and means of overcoming this challenge with what fighter equipment they had at hand, mainly the Wildcat.

The success of these huddles and the tactics developed through them is evidenced by the amazing box scores hung up by our pilots in the southwest theater of operations. To quote a Navy-approved Grumman release: "In the Pacific the Wildcat achieved a combat record of better than ten to one against the Zeros and Jap bombers," and one fighter squadron, Navy Fighter Squadron Five, ("Tojo Meets a Wildcat," P.S.M., Aug. '43, p. 96) bagged 93 Japs in nine weeks. But this was still defensive football as far as the pilots were concerned.

The F4F's had guns, armor, and leak-proof tanks and would hold together when hit, but our pilots cried for steeds worthy of their ambitions. The F4F's could take

*See page 4 for sketch of the author.

HOW TO TELL THE DIFFERENCE BETWEEN THE WILDCAT

plenty and *DID*, but because of this they could not compete in climbing speed and aerobatics with the Zeros. Heavy armor, safety tanks, and rugged construction, plus guns, held them back. Their best tactics, as one pilot put it, were on the "hit-and-git" order.

This was always defensive activity, and American pilots don't like defensive playing or fighting. The cry was for faster and better-climbing planes, with better firepower and armor if possible, and the ability to out-Zero the Zero in any maneuver.

When President Roosevelt pinned the Congressional Medal of Honor on Lt. Comdr. Edward H. ("Butch") O'Hare, U S N , he asked him a question:

"Butch, what kind of fighter plane do you need to beat the Japs?"

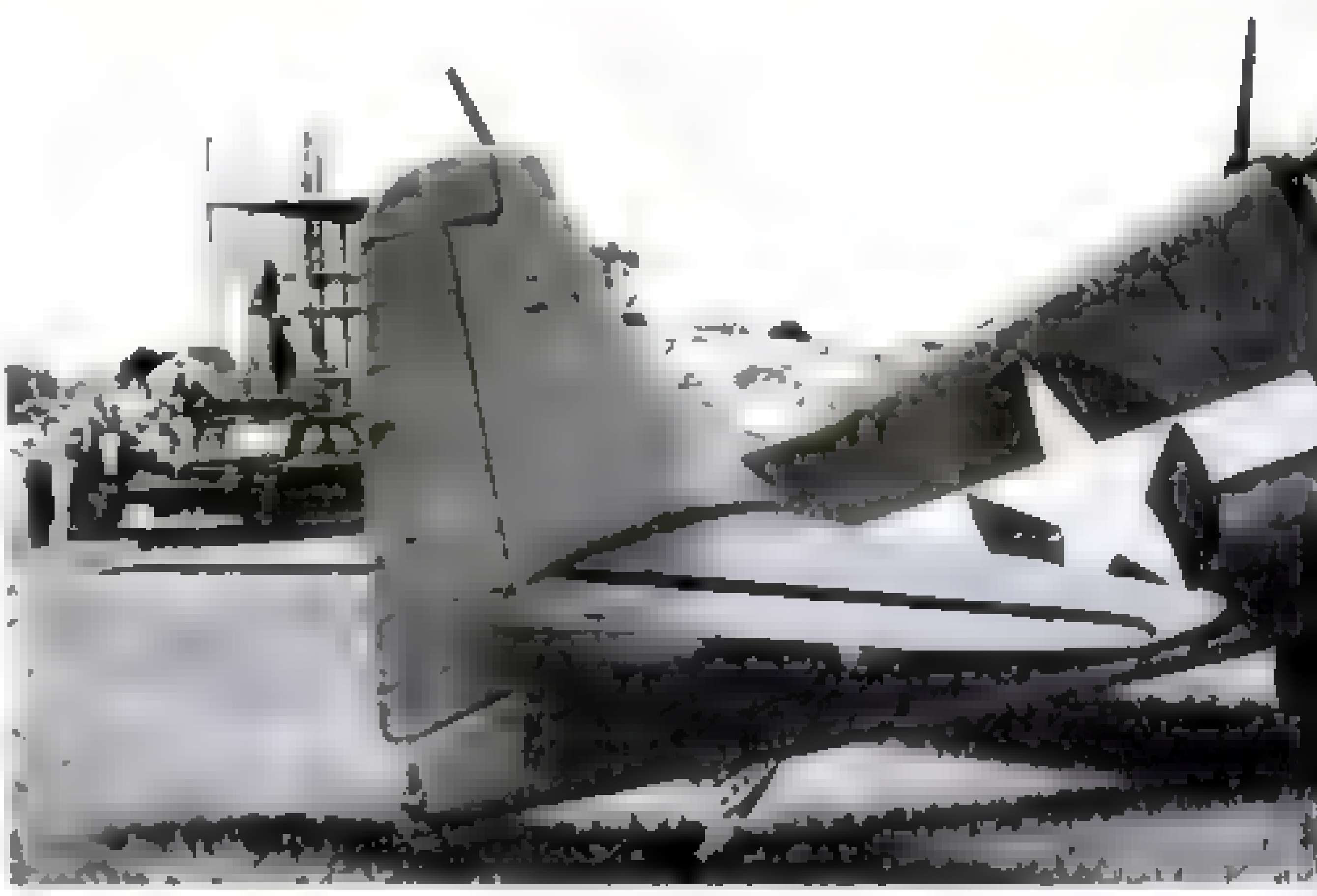
"Something that will go upstairs faster," was O Hare s reply.

Things have to happen fast in wartime, and they did. Leon A. ("Jake") Swirbul, Grumman's dynamic vice-president and general manager, stuffed a notebook and a spare shirt into a musette bag and hustled out to Pearl Harbor almost before the smoke of the battle of Midway had ceased to eddy, and went into a huddle with the pilots. He wanted to find out what they wanted in a plane, not what Congress or some theorist *thought* they wanted. One pilot in particular was questioned—Lt. Comdr. John Smith ("Jimmy") Thach, U.S N., one of the Navy's best authorities on fighter tactics and a squadron leader of long experience against the Japs.

Jimmy in four words gave Jake the formula for the plane they wanted: "More climb and speed."

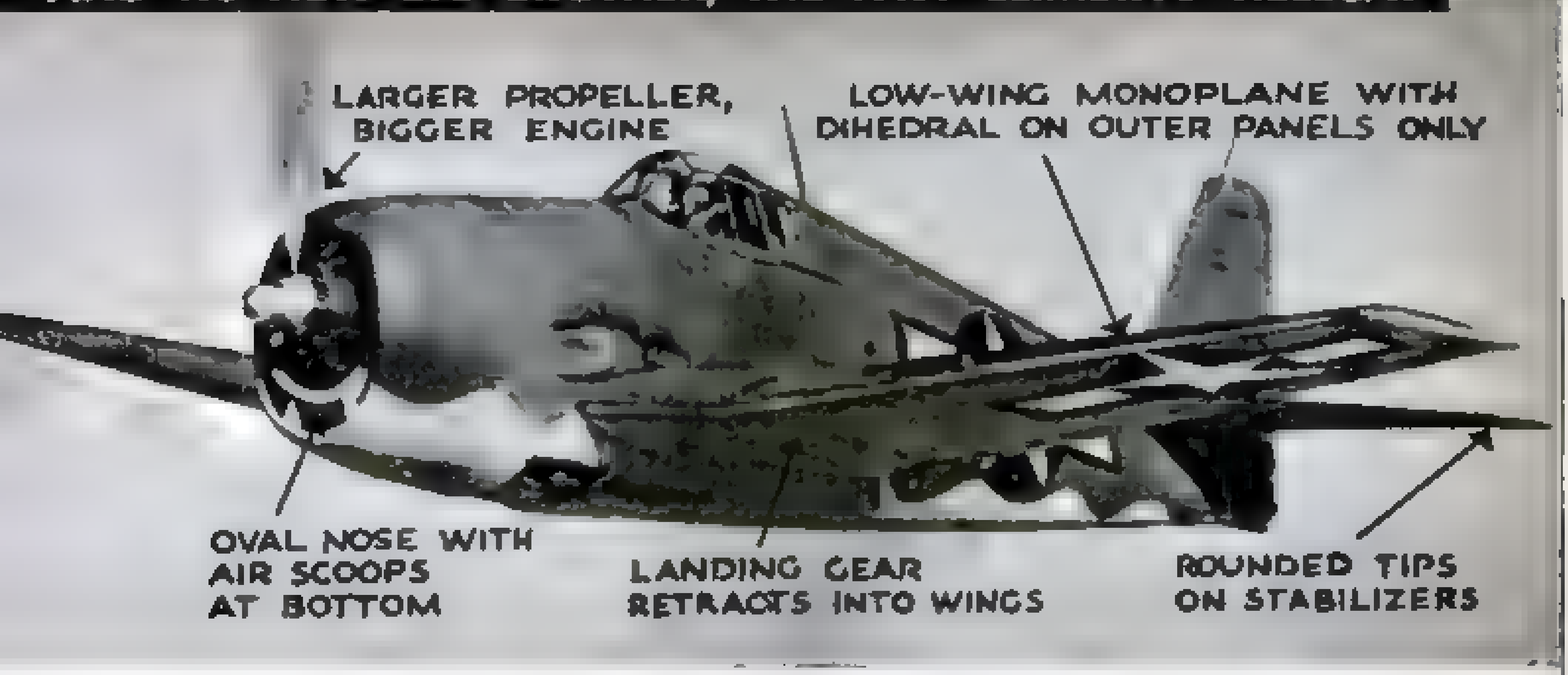
Jake snapped his notebook shut, repacked his shirt and hustled right back to Long Island, N. Y., where he and William T. ("Bill") Schwendler, co-designer with Leroy R. Grumman of the Wildcat, got their heads together.

These two condensed the four-word formula of "more climb and speed" into a one-word aircraft—Hellcat! (See P S.M., Nov. '43, p. 72.) This ship, designed by and for pilots in action, is a worthy successor to the



ROUNDED STABILIZER TIPS differ from the square tips of the Wildcat. Tail planes are of laminar-flow design, which reduces tail buffeting from the slip stream. The Hellcat's low-set wing has square tips, and has been made short and stubby for better maneuverability

AND ITS NEW BIG BROTHER, THE FAST-CLIMBING HELLCAT



OVAL NOSE of the new fighter. It is narrower and has the openings for the cooling units on the bottom rather than on top, as in the Wildcat model

LANDING GEAR retracts into the wing rather than into fuselage. Note that the wing root has little, if any, dihedral, while the dihedral of the outer wing panel is quite obvious. This is the most conspicuous difference between the two planes

famous Wildcat, which held the fort during the incubation of its younger but tougher brother.

To get the required attributes into such a ship as the F6F Hellcat, Jake, Bill, and Roy needed more power. Not merely more power for speed and climb, but power to give, along with these demanded qualities, what our country believes our fighters deserve—armor, leakproof tanks, all the guns needed, and every safety device that can be packed into the compact aerial gun platform we call a fighter plane.

This "more power" meant to the Grumman Company a new high-altitude Pratt & Whitney engine already in production—the most powerful thing Navy combat flying had known in the shape of a power plant.

Speed was the spur, and already the plans for the Hellcat were in tentative form, for the Grumman Company, having learned of the coming of this engine, had laid plans for a ship to carry it. These plans were now modified to follow the suggestions and demands of the O'Hares and Thaches. A new factory was rushed to completion, even as the first experimental plane was undergoing tests.

This first plane flew in August, 1942, and at that time ground was broken for the factory to produce the new fighters in quantity. In September the first handmade model was delivered. In October the first jigs were installed and production parts

FLAPS contribute to the easy handling of the Hellcat. It's a fighter pilot's delight . . . climbs practically straight up . . . does slow and fast rolls while climbing . . . can even do a half roll and reverse

WINGS FOLD as shown below for carrier stowing. They rotate forward, then fold back by a method similar to the one used on the Grumman Avenger (TBF). The prop is a Hamilton-Standard hydromatic unit with three blades

began to pile up. In November the first production plane rolled out of the doors, even though the plant was but three-quarters finished and the workers were working without heat.

It is a tribute to Grumman production and design that, according to an official of the Bureau of Aeronautics, there has never been a plane in the history of the bureau with fewer "bugs," or defects that have to be remedied before the plane can be put into all-out production.

The Hellcat inherited all the good qualities of the Wildcat, plus plenty more. Weighing thousands of pounds more than the F4F, itself no pygmy, the Hellcat has, nevertheless, greatly increased range, speed, climb, and ceiling, plus that most important of qualities, lightning maneuverability. Like many other U. S. fighter planes, it can also carry bombs, a full-size torpedo, or an auxiliary belly tank.

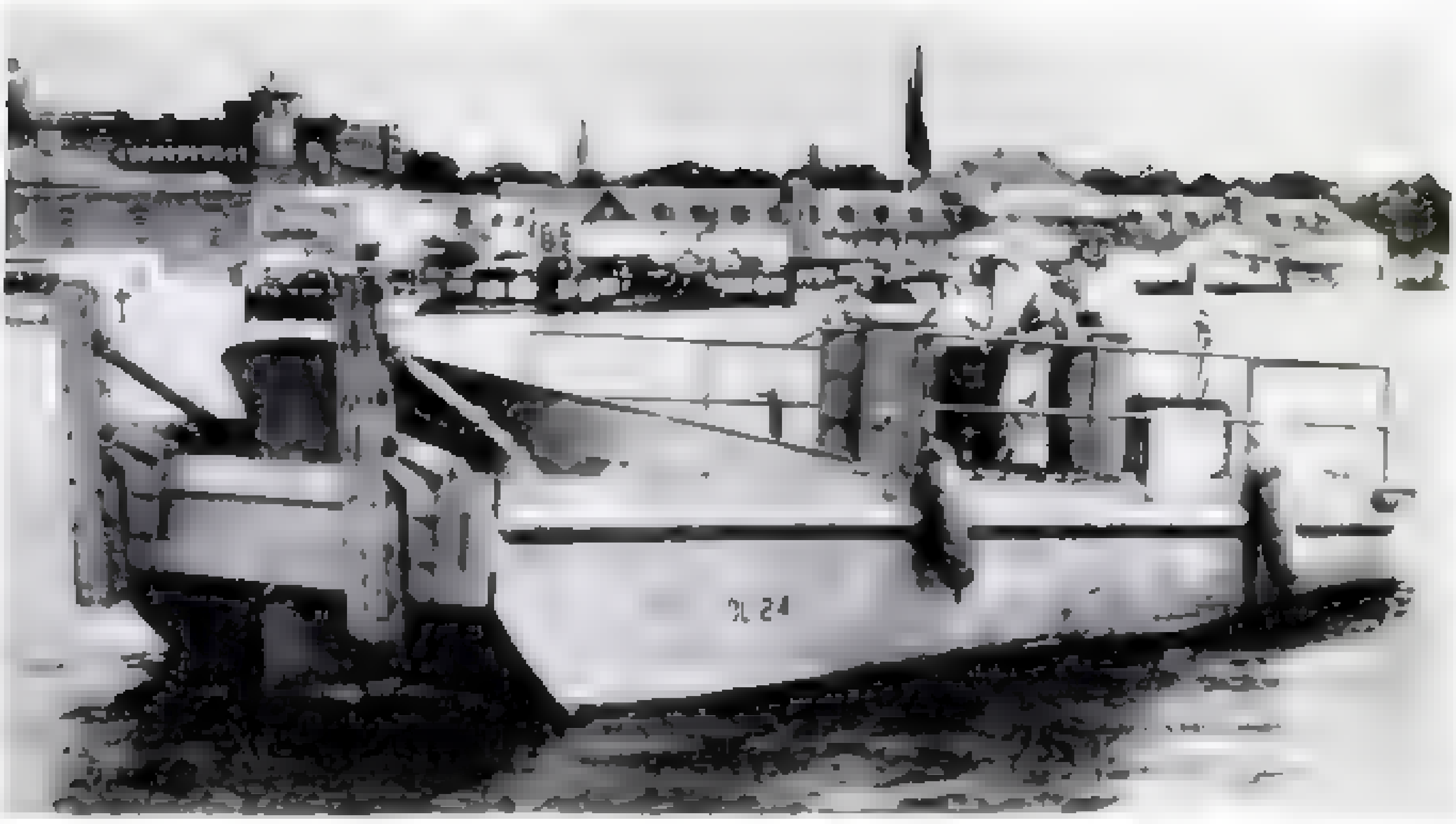
As one fighter pilot said after putting it through its paces, his one worry in tight turns would be that he might shoot his own tail off with his wing guns!"

This maneuverability, built in by the genius of Grumman engineers' handling of wing design and equipment, enables the tons-heavy Hellcat to be tossed about with the abandon of a trainer. This, combined with its improved armor, its batteries of .50 caliber guns fed by extra large ammo boxes, gives it a very long combat life.

A unique placing of the engine gives added visibility, one of the "musts" demanded by the pilots, plus added ease in handling on take-off and in turns. The engine mount, instead of being at the conventional right angles to the longitudinal axis, is canted to one side. This gives a narrower front, aiding visibility forward and down, plus a decrease in propeller torque, which has a tendency to swerve the plane in take-offs and maneuvers.

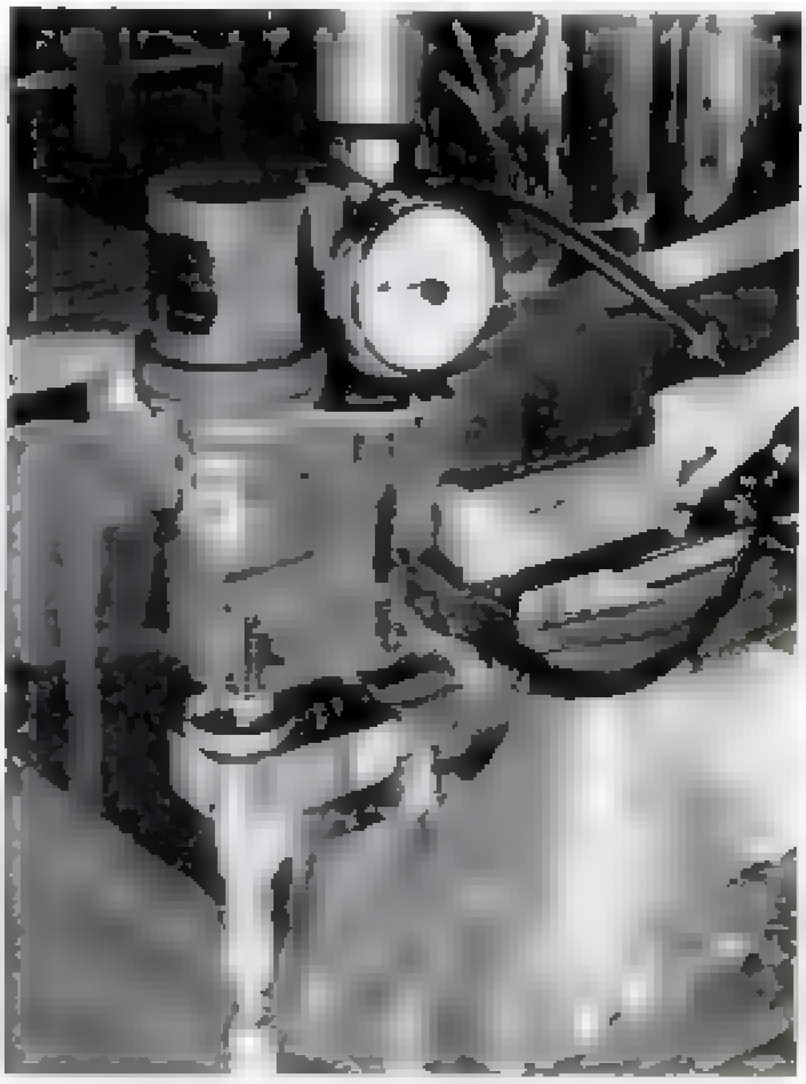
These added qualities were attained through the clever translation of design demands into proved engineering procedures.

All in all, the Hellcat *had* to be, for it was sorely needed; it had to be because Grumman engineers could produce it, and because our O'Hares and Thaches and Jones and Polonskys asked for it!

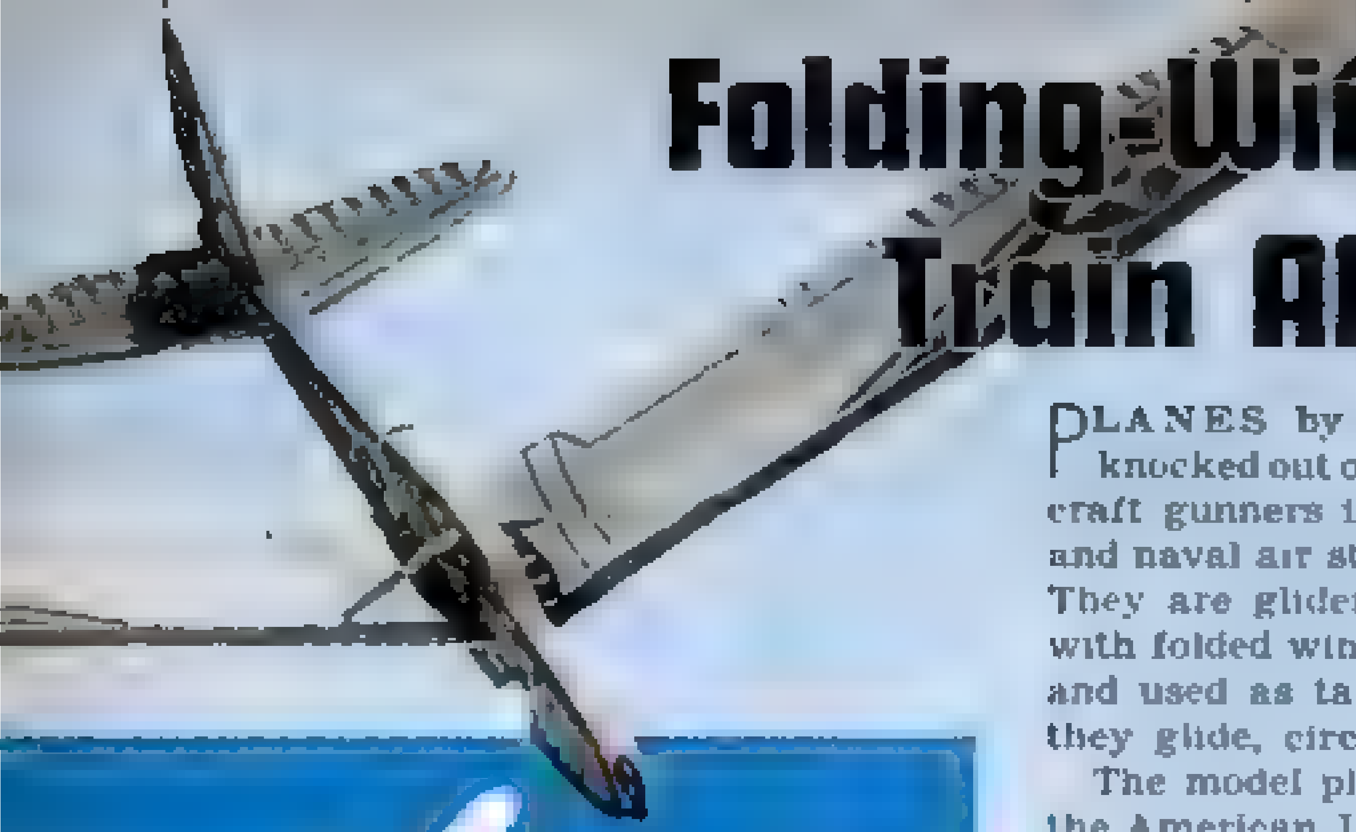


A PORTABLE TUGBOAT is the latest invention to take Army craft in tow. The vessel, which can be dismantled and put together in three hours, is of all-steel construction and is powered by two gasoline engines. Army officers say this "river jitney" is more maneuverable than an ordinary tug. It takes a week to build and can tow 400 tons. Here the new marine tractor is seen churning up the Potomac.

ELECTRICITY instead of needle and thread is used to "sew" sheets of aluminum together for wing coverings of the Boeing Flying Fortress. Since each wing is nearly a half block long, many nine-by-five-foot sheets must be joined by the fast, accurate spot-welding machine. While ladderlike clamps hold the metal, as seen at the lower left, each machine makes 86 welds a minute, placing them .502 inch apart in four parallel rows. The close-up shows the spot-welder at work on one row. The spots form joints that are 80 to 90 percent as strong as the sheets themselves.



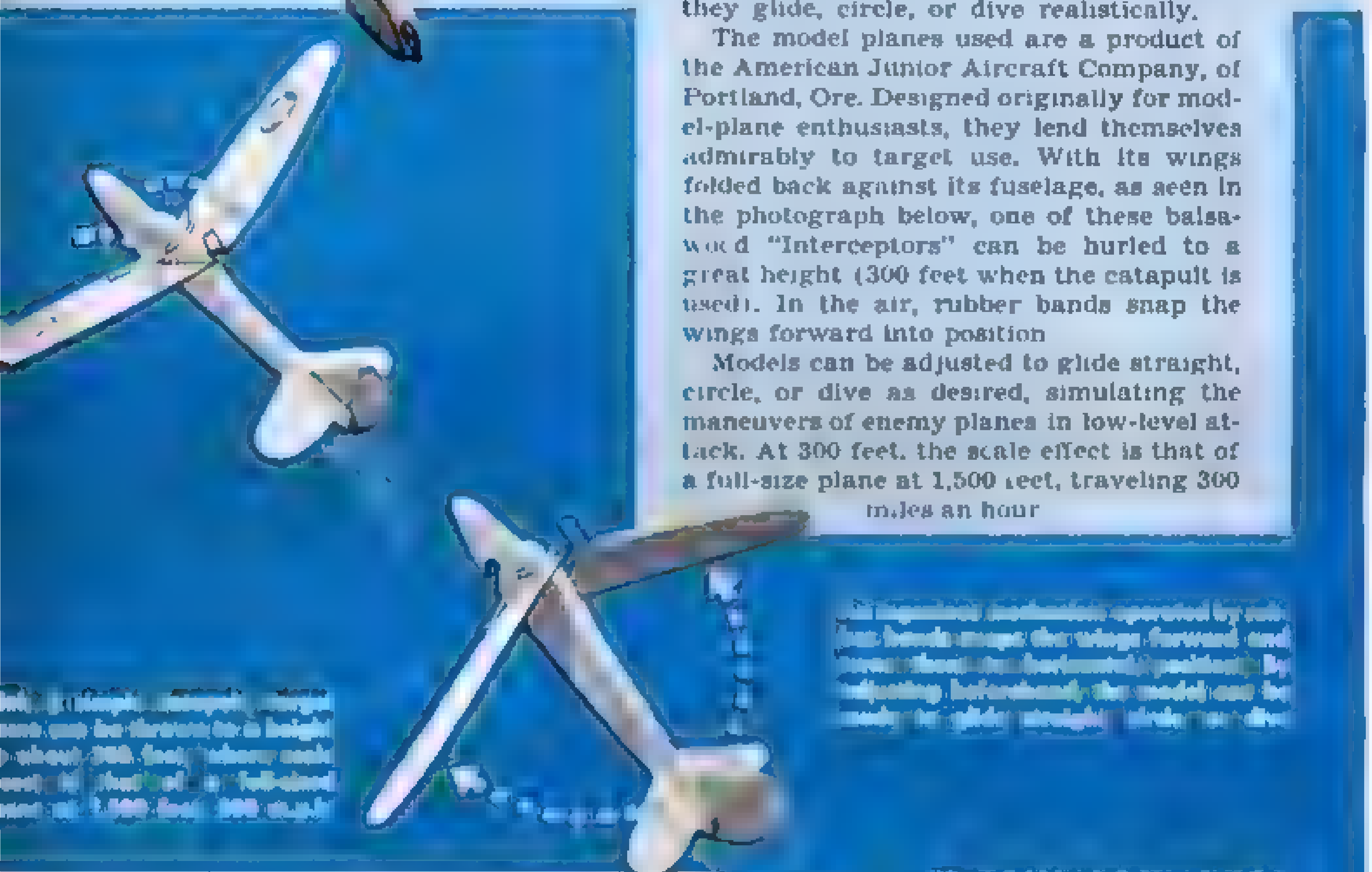
Folding-Wing Gliders Train AA Gunners

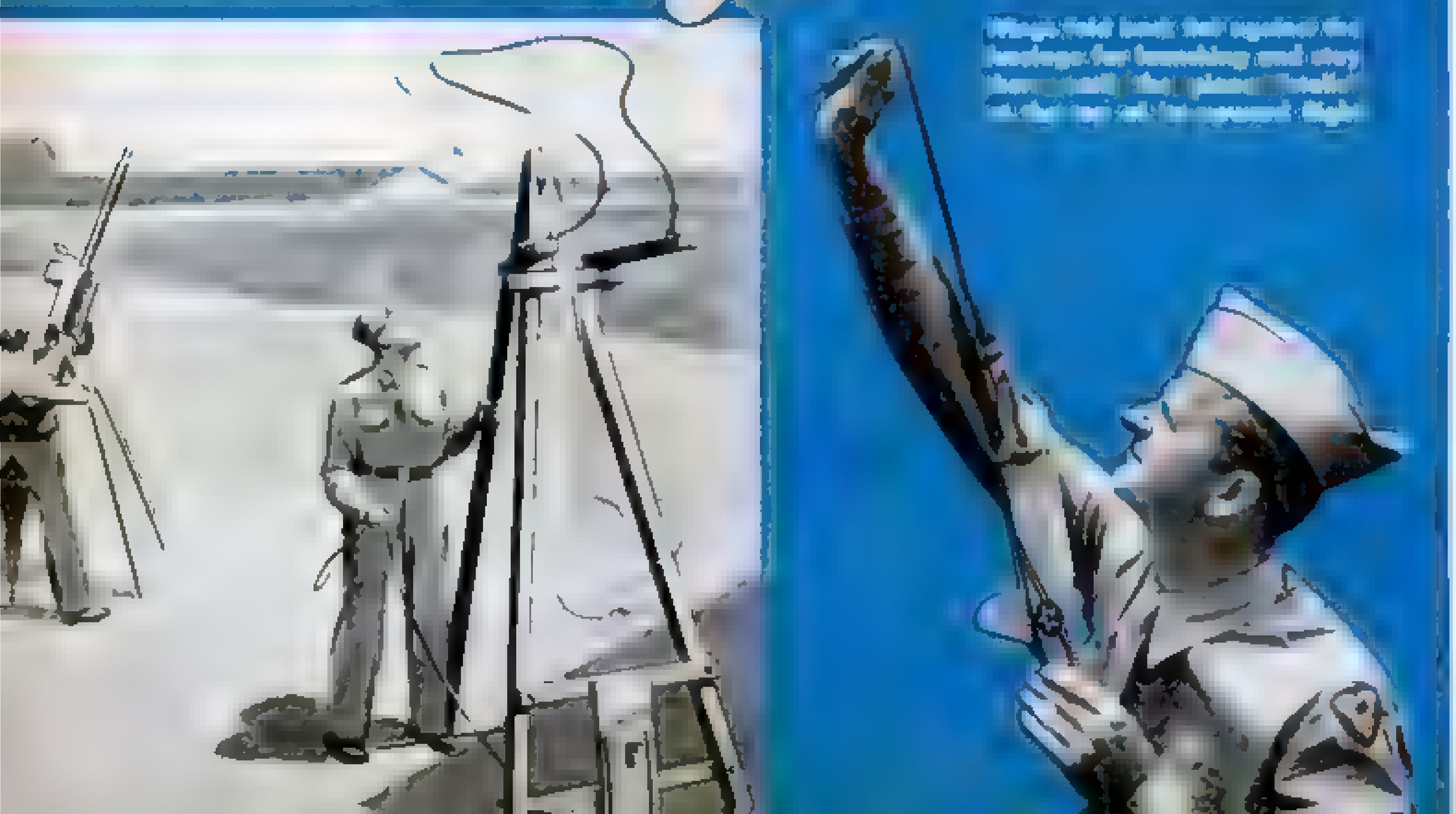


PLANES by the thousands are being knocked out of American skies by antiaircraft gunners in training at Army camps and naval air stations all over the country. They are glider models, shot into the air with folded wings from slings or catapults and used as targets for machine guns as they glide, circle, or dive realistically.

The model planes used are a product of the American Junior Aircraft Company, of Portland, Ore. Designed originally for model-plane enthusiasts, they lend themselves admirably to target use. With its wings folded back against its fuselage, as seen in the photograph below, one of these balsawood "Interceptors" can be hurled to a great height (300 feet when the catapult is used). In the air, rubber bands snap the wings forward into position.

Models can be adjusted to glide straight, circle, or dive as desired, simulating the maneuvers of enemy planes in low-level attack. At 300 feet, the scale effect is that of a full-size plane at 1,500 feet, traveling 300 miles an hour.



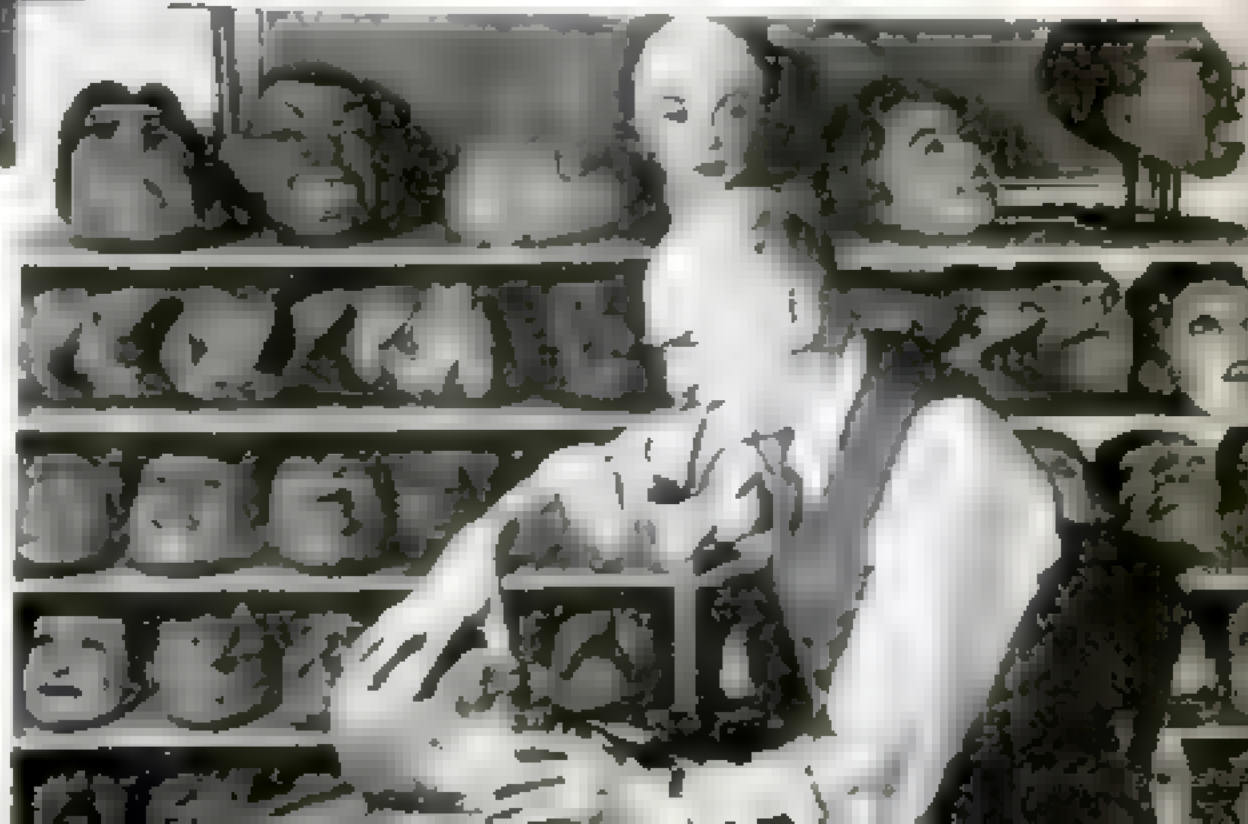


Photographs by HANS REINHART

THESE FACES ARE FAMILIAR . . . HOW MANY DO YOU RECOGNIZE?

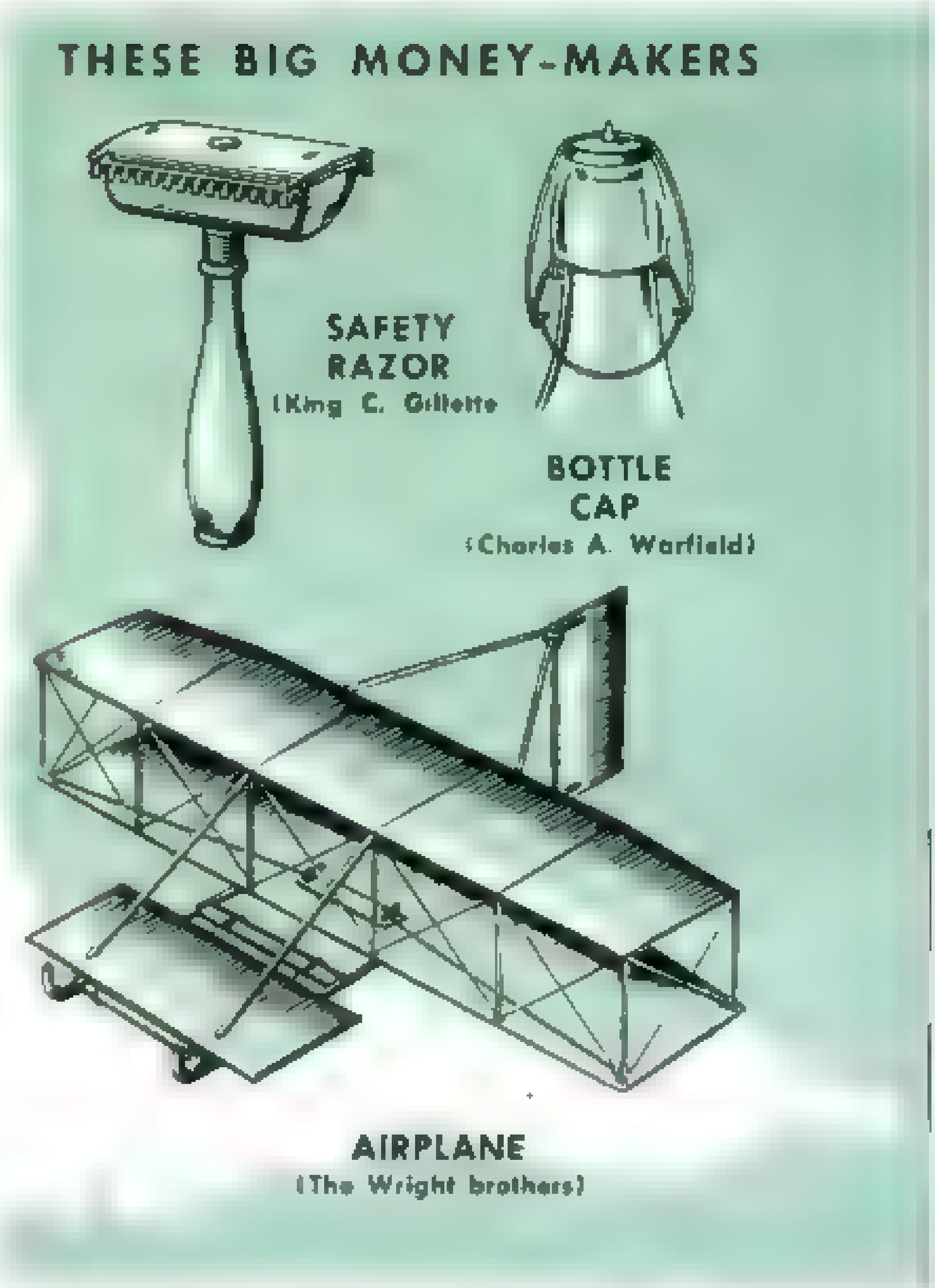
MAKING faces is the odd hobby of Doane Powell, New York City artist. Combining his early experience as a political cartoonist with his skill in oil portraiture, he came up with a new form of sculpture in soap and wrapping paper. From a "mush" composed of these ingredients he molds the features of famous persons in lifelike masks. Statesmen, politicians, dictators, and famous women rest cheek by jowl on the shelves of his private collection. How many of the 15 masks above can you identify? See page 234

IS THIS THE FACE that launched a thousand strikes? Eyebrows that wag menacingly at the WLB are a prominent part of this mask by Doane Powell, who is seen at the right adding another famous physiognomy to his collection. He models his masks from a mush of soap and wrapping paper, over a solid base, and then dries them in the sun, on a radiator, or in the warm blast from a hair drier. Coloring with oil paint gives realism and permanence. Faces of celebrities are modeled from the best available photographs. More obscure individuals may "sit" for a



No More

Proposed legislation for "compulsory licensing" of patents would remove the incentive that has made Yankee ingenuity famous around the world.



It was the prospect of financial gain that inspired the great inventions which have contributed so much to the ease and

ABRAHAM LINCOLN, the only President of the United States to whom a patent ever has been granted, once said that our patent system "adds the fuel of interest to the fire of genius."

When he made that remark, Honest Abe wasn't thinking about his own invention, which never earned a cent for him. (It was a bellows device he proposed to attach to the hull of a boat just below the water line for floating the craft over shallow places.) What he meant was that our patent system holds out to an inventor a dollars-and-cents incentive sufficient to make it worth his while to go short on sleep, miss meals, and put up with the embarrassment of having his neighbors think him screwy while he sweats through the painful process of developing a bright idea into a patentable invention.

Legislation which has been proposed to Congress would remove much of that monetary spur to inventive enterprise. It would weaken and probably wreck the 153-year-old patent system that has played so vital a part in making the United States the world's leading industrial nation.

Contrary to general belief, the Constitution does not give inventors the exclusive right to benefit from their inventions for a term of years. It merely gives Congress the power to give inventors that exclusive right. That is a very different thing. What Congress can give, Congress can take away!

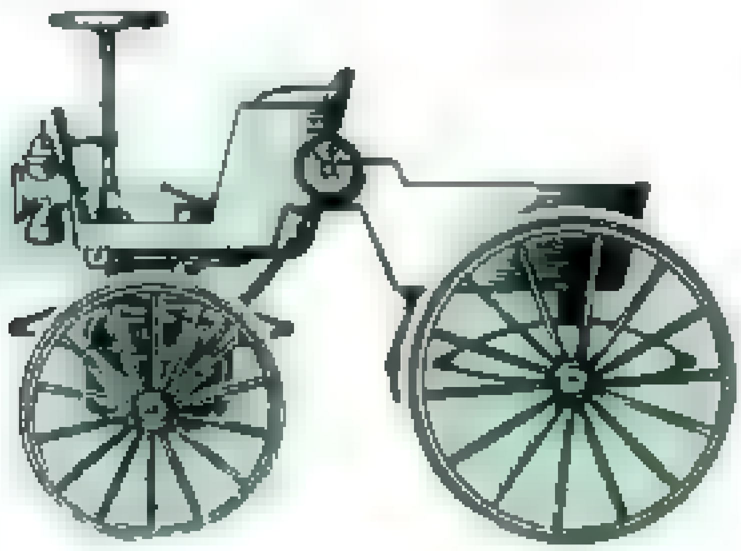
During the 17 years of his patent's life, an inventor now can do exactly as he pleases with his invention. He can put it into manufacture and sell it himself. He can make a royalty deal giving someone else the right to manufacture and sell it. He can make and market it himself in one territory, and lease to others the right to make and market it in other territories. He can sell his patent outright, and—if he gets enough for it—go fishing for the rest of his life.

The strongest argument for continuing our American patent system without radical change is that it has worked better than any other patent system except those which have been modeled after it. It has stimulated invention until an application for a patent is filed every 8½ minutes around the clock, and a patent is granted every 11 minutes.

Among the 2,250,000 patents that have been issued to American inventors are those which form the foundation of our industrial might and make possible the American way of life. Most of these world-changing inventions have earned fortunes. So have the simpler inventions, which merely contributed to the convenience and pleasure of life. One of the big money-makers was the first im-

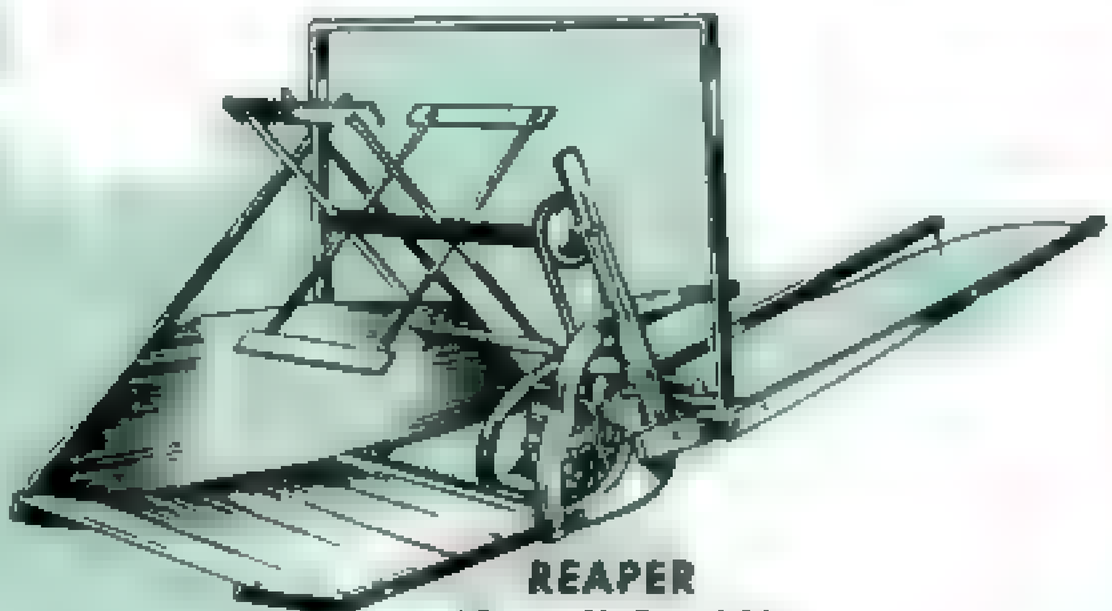
Fortunes for Inventors?

EMERGED UNDER OUR PRESENT PATENT SYSTEM

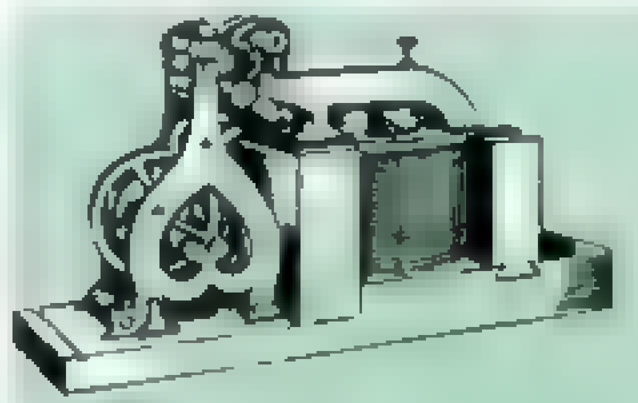


AUTOMOBILE
(George B. Selden)

TELEPHONE
(Alexander G. Bell)



REAPER
(Cyrus McCormick)



TELEGRAPH
(Samuel Morse)

convenience of life. It is the opinion of many observers that compulsory licensing of patents would deprive inventors of their deserved monetary rewards, and thus greatly discourage the output of American inventions

provement on the bottle cork—a rubber stopper tightened by a wire attachment which acts like a lever. It made $15,000,000 for its inventor. The metal bottle cap also piled up a large fortune. So did rubber heels. The inventor of the grooved umbrella rib cashed in for a million, as did the inventor of tire chains. The inventor who thought up the pre-electric flatiron that had a detachable handle which stayed cool while the iron was getting hot made a half million. The safety pin and the crinkled hairpin both brought the financial bacon home to their inventors. Many inventions of today are earning big-time royalties, but figures are not obtainable.

The purpose of the proposed legislation being urged upon our lawmakers is to force inventors, by a system of compulsory licensing under their patents, to share their inventions with anyone and everyone who wants to use them and is willing to pay a royalty for the privilege—the size of the royalty to be decided by the Government if the inventor and the would-be licensee can't agree on terms.

One of the arguments of those who believe in compulsory patent licensing is that it would help the independent inventor to make money out of his inventions, and help the small manufacturer to compete successfully against big business.

John W. Anderson, who protested recently to the Senate Patents Committee against the adoption of the proposed legislation, which he thinks would weaken our patent system, is both an inventor and the president of a small manufacturing company that

specializes in products embodying new inventions. He told the senators that at present the smaller manufacturer, *protected by his exclusive patents,* has a fair chance against his big rivals—that "usually he can get a washing on the line before his corpulent competitor can find the soap." In his judgment, the most effective method that could be devised to discourage inventors from continuing to invent would be the enactment of a compulsory-licensing law.

With such a law in effect, the average inventor would find it very difficult to make any real money out of his patent. If he started manufacturing his invention himself, and it proved commercially profitable, some big company would be certain to demand and obtain a compulsory license to manufacture and sell it in competition with him. He couldn't make a royalty arrangement giving someone else the sole right to make and sell his invention. He probably couldn't sell his patent outright for a decent price, because no business man in his financial senses would pay a sizable sum for a patent, and risk another sizable sum in starting to manufacture under it, knowing that as soon as he had established a market someone would demand a compulsory license to produce the invention in competition with him. Under a compulsory-licensing law, all the average inventor could do would be to accept whatever royalty offers were made him, and hope that his profits from them would be large enough to repay him for the work, worry, and time he had devoted to developing his original idea into a patent.

Another argument of those who believe in the adoption of a compulsory-licensing law is that it would benefit the public by resulting in a quicker and more widespread use of new inventions and processes.

Men who have had long experience in industrial-research work think that such a law would have exactly the opposite effect.

Dr. Robert E. Wilson, formerly director of research at Massachusetts Institute of Technology, who as an inventor and co-inventor has been granted 90 patents, and whose outstanding achievements in industrial research won him this year's award of the Perkin Medal of the Society of Chemical Industry, warns that depriving inventors of the protection now given them by the *exclusive* right to use their inventions would result in the big industrial laboratories keeping their discoveries under cover instead of announcing them as they do now; that secret processes soon would replace many of the patent-protected inventions of today; and that eventually the use of industrial spies by unscrupulous competitors would force many of our most important research laboratories to supplant their present open-door policy with an unwholesome one of strict secrecy.

Still another argument of many supporters of the proposed compulsory-licensing system is that it would make all inventions useful in war available to the Government. No new legislation is needed to do that. Existing laws give the Government and its contractors and subcontractors the right to manufacture and use, on payment of reasonable compensation to the inventor or patent owner, any invention that the Government considers necessary for national defense or for the protection of the public health or safety.

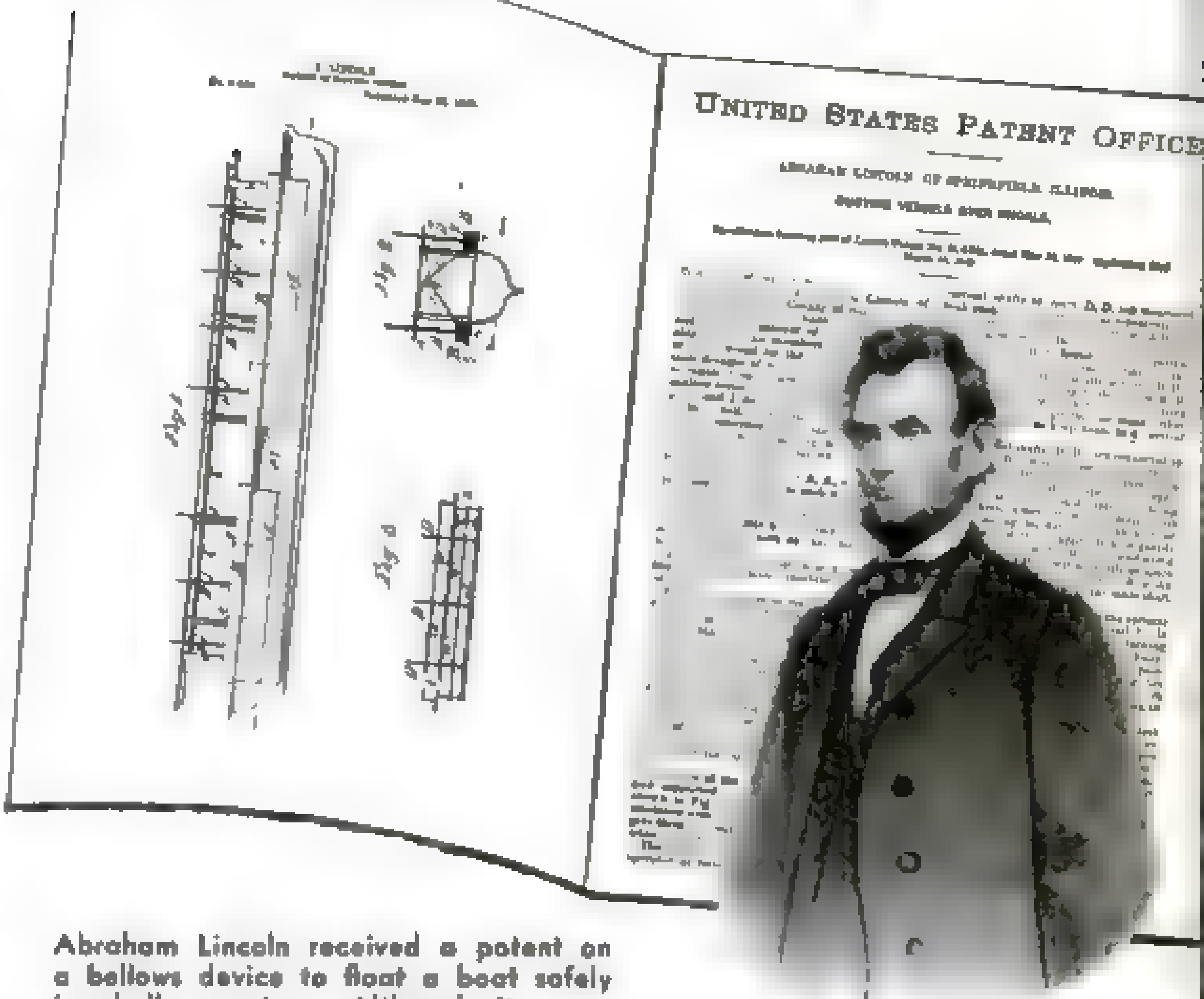
Many inventors think that Congress should go considerably farther than merely refusing to enact the proposed compulsory-licensing law—that the lawmakers should prolong the 17-year life of all unexpired patents which were issued between 1930 and 1940, and increase proportionately the life of patents granted during the war. They contend that many patents which were issued during the slack years never had a fair chance because business conditions were so bad that no one would risk exploiting them, and that after the war their remaining life will be so short that their exploitation won't be financially worth while. They foresee, too, that many patents granted during the war will have little chance of prompt development because in the early postwar years manufacturers will be so busy meeting the tremendous demand for staples that few of them will have either incentive or free facilities for the making of goods embodying new inventions.

Two years ago President Roosevelt appointed the National Patent Planning Commission, with Charles F. Kettering as chairman, to study our patent system and to recommend any changes in it that the Commission thought desirable.

After considering very carefully the compulsory-licensing legislation which has been proposed to Congress, and the operation of the compulsory-licensing system in countries which have adopted it, the Commission refused to recommend the emasculation of our patent system by the enactment of this proposed legislation. But its members were impressed by the advantage it would be to the independent inventor to have some method by which he could bring his patent to the attention of manufacturers who might be interested in exploiting it, and recommended the establishment in the Patent Office of a public register of patents on which would be entered, *but only at the request of the patent owner,* patents under which the owner would be willing to grant licenses on stated or "reasonable" terms—the latter, if the patent owner and manufacturer were unable to agree on the terms, to be fixed by the

Commissioner of Patents, with both of the interested parties having the right of appeal to the courts.

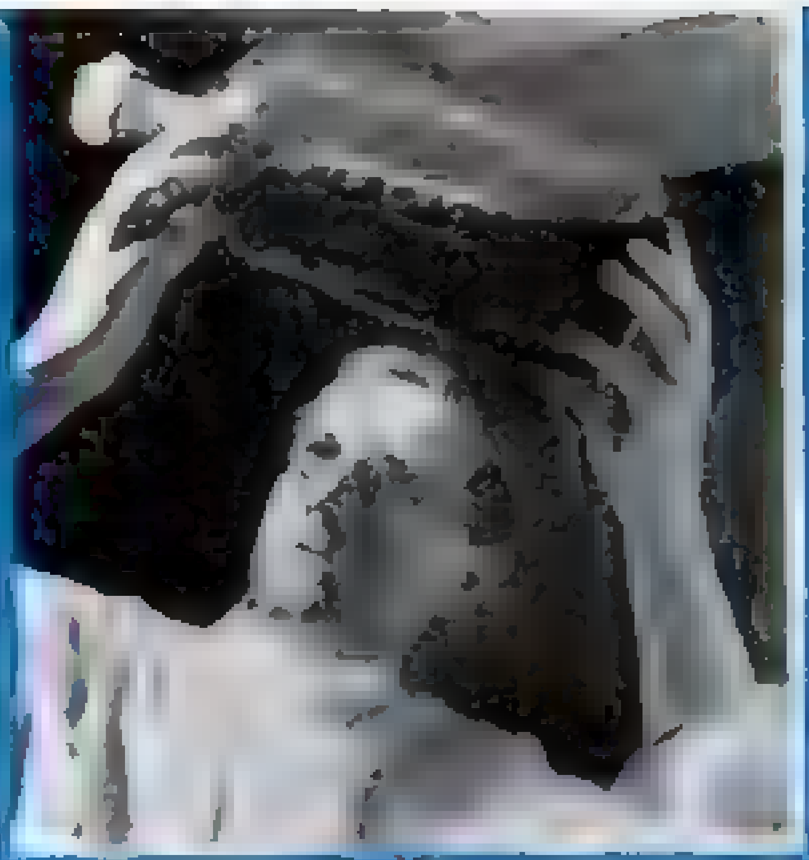
Our patent system isn't perfect, but it has done a good job all through the 153 years of its existence. The change recommended by the Patent Planning Commission is intended to strengthen it; and not, as a judge recently remarked, to "throw out the baby with the bath water"—which is what the enactment of the proposed compulsory - license - system law would do.



Abraham Lincoln received a patent on a bellows device to float a boat safely in shallow waters. Although it never earned him a cent, it was his firm belief that, under our patent system, the hope of realizing a fortune added "the fuel of interest to the fire of genius"

Over 300 years ago, the first American patent, for a new way of making salt, was issued to Samuel Adams by the Colony of Massachusetts. Later, when the 13 colonies were welded into a nation, the inventor's rights were not forgotten. In 1787, when the Constitution was framed at Philadelphia, the following article was included: "The Congress shall have power . . . to promote the progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive right to their Writings and Discoveries." Since that time, there have been several changes in the patent laws, but they have remained the same in principle. Their success in fostering invention should make us hesitate before changing them.—ARTHUR GRAHAME.

Inventiveness is as typically American as corn on the cob. Since 1790, over 2,250,000 patents have been granted by the Patent Office. The patent shown at the left was issued in 1791 and signed by George Washington



PENICILLIN

Ten New Triumphs in Medicine

MAGIC DRUGS, INGENIOUS INSTRUMENTS, WIDER KNOWLEDGE MARK THE RAPID ADVANCEMENT OF THE LAST THREE DECADES

By IAGO GALDSTON, M. D.

Author of "Progress in Medicine" and "Behind the Sulfa Drugs"

WITHIN the short span of the past 30 years more truly great inventions and discoveries have developed in the field of medicine than in any comparable period during the entire history of the science. In times past, important discoveries often were followed by long periods of little or no progressive medical thinking. Today, discoveries of the utmost importance are following quickly on each other's heels.

Among these inventions and discoveries is an instrument with a moving pen, which can "take dictation" from a patient's brain. The record of electrical brain waves that this amazing secretary takes down is read by the surgeon for indications of brain disorders. Another is a drug so powerful that one part in 25 million parts of water will stop the growth of bacteria. Still another has revolutionized the science of diagnosis, and has completely recast the modern physician's approach to the problem of healing.

In this writer's judgment, 10 of the greatest medical discoveries and inventions of recent years are: The sulfonamides; penicillin; the vitamins; the sex hormones; the relation of the sex hormones to cancer; the electro-encephalograph; the electron microscope; psychosomatic medicine; brief therapy; and biological thinking.

The Sulfonamides

The sulfonamides are without doubt the best known of the recent medical discoveries. And justly so, for no single group of compounds has proved as effective as this one in preventing and treating such a large number of diseases. Pneumonia, gonorrhea, erysipelas, childbed fever, many forms of bloodstream infection, trachoma, septic sore throat, urinary infections, meningococcus meningitis, chancroid, gas gangrene, actinomycosis, anthrax, scarlet fever, impetigo—these are but some of the conditions effectively treated with one or another of the sulfonamide compounds.

Equally remarkable and numerous are the applications of the sulfonamides in the *prevention* of infection. Since their first use in this respect, the lives of countless men wounded in battle have been saved. The sulfonamides have also extended the scope of surgery, heretofore limited by the threat of infection supervening upon operations in contaminated regions. They are reducing the incidence of serious complications which in times past frequently followed on simple infections. There is, however, one particular aspect of the discovery of the sulfonamides which overshadows even its great practical results. The sulfonamides have given new life to the science of chemotherapy—the treatment of internal disease with chemicals.

Chemotherapy got off to a great start when Paul Ehrlich discovered Salvarsan in

1910—although for the next 25 years little new appeared on the chemotherapeutic scene. Then in 1935 came Prontosil, and later the sulfonamides, and the whole picture changed. But what changed most was the concept of chemotherapy itself. Paul Ehrlich and practically all of his followers thought of chemotherapy in terms of "magic bullets," that is, in terms of protoplasmic poisons which would kill germs, but not the human body. Unfortunately few such selective poisons were found. Most of the protoplasmic poisons proved as likely to injure the victim as the attacking germs. Then when Prontosil and the sulfonamides were found to be so amazingly effective against bacteria, the old theories of chemotherapy had to be recast, for the sulfonamides do not belong to the class of protoplasmic poisons. In fact, the sulfonamides are not even bactericidal, that is, they do not directly kill germs. They are, however, bacteriostatic: they arrest the development of germs by interfering with their metabolism. By thus weakening the germs, they make it possible for them to be overcome by the body's own defenses.

Today, research follows the path of germ metabolism, and seeks to discover how that metabolism may be adversely affected by means of chemical agents. It is this new rational basis for chemotherapy that warrants our hope of finding chemicals with which to cure tuberculosis, leprosy, malaria, and other germ and virus diseases not affected by the sulfonamides.

THESE RECENT DISCOVERIES PROMISE YOU LONGER LIFE

SULFONAMIDES
fight pneumonia, erysipelas, impetigo, scarlet fever, trachoma.

PENICILLIN
is effective against osteomyelitis, empyema, persistent infections

VITAMINS
increase resistance to disease, promote growth and good health.

SEX HORMONES
effectively treat disturbances of sexual and reproductive functions.

HORMONES—CANCER
Sex hormones are being used to retard prostate cancer growth

ELECTRO-ENCEPHALOGRAPH
visibly records "brain waves" indicating mental disorders.

ELECTRON MICROSCOPE
is affording scientists a new insight into structure of viruses.

PSYCHOSOMATIC MEDICINE
has made possible better diagnosis and more effective medical care.

BRIEF THERAPY
will reduce both the time and cost of psychiatric treatment.

BIOLOGICAL THINKING
prompts doctors to seek the environmental causes of sickness.

Penicillin

Hot on the heels of the sulfonamides came the discovery of penicillin, a chemotherapeutic agent in many respects superior to the sulfonamides. This powerful new drug is derived from a fungus called *Penicillium notatum*. In 1929, this fungus, or mold, was an unwelcome intruder into some staphylococcus cultures with which the English bacteriologist Prof. A. Fleming had been experimenting for quite some time. Fleming acutely observed then that wherever the fungus grew, the germs did not, and he reasoned that the fungus and the germs did not get along well together. He studied the matter further and found his reasoning correct. However, since the fungus was not antagonistic to all germs, but only to certain ones, he employed it to eliminate from groups of mixed germs those to which penicillin was antagonistic. But that was as far as the matter went at the time.

With the discovery of the sulfonamides it was natural for the scientists to turn their attention once again to the penicillium mold. Another English scientist, Prof. H. W.

Florey, in 1940 extracted from the penicillium mold a brown powderlike substance. He found it to be an extraordinarily powerful drug, effective against a larger variety of infections than are the sulfonamides.

Though but recently discovered, penicillin has already been subjected to numerous trials. Unlike the sulfonamides, which operate by diminishing the growth of bacteria, it has been found to kill bacteria or stop their growth entirely. But it will work in many cases where the sulfa drugs have proved useless or only partially effective. Penicillin operates, as the sulfonamides do not, in the presence of pus and tissue fluids. This renders it particularly valuable in the treatment of such conditions as osteomyelitis, empyema, infected compound fractures, and wounds and burns with long-established infections. Penicillin is superior in undermining the yellow pus-producing bacteria, the *staphylococcus aureus,* and many infections caused by cocci. And the user of penicillin suffers no toxic effects such as are sometimes experienced when sulfa drugs have been employed.

Unfortunately we cannot as yet produce penicillin in large quantities, and what is being produced has been preempted by the Government for military use. There is, however, no reason to doubt that the chemists will before long succeed in crystallizing it and reproducing it artificially.

The Vitamins

The vitamins represent a major medical discovery of an order different from any of those thus far described. Biology and medicine have been radically affected by their discovery. Until vitamins were discovered, the conviction prevailed among medical men that there wasn't much one could do about health except to prevent disease. Doctors preached personal hygiene in terms of rest, cleanliness, exercise, fresh air, and good food. But they did so in the belief that they could only *preserve* health, which for any given individual was more or less fixed. For the rest, attention was focused on "fighting infection" by such means as vaccines, serums, antiseptics, and so forth.

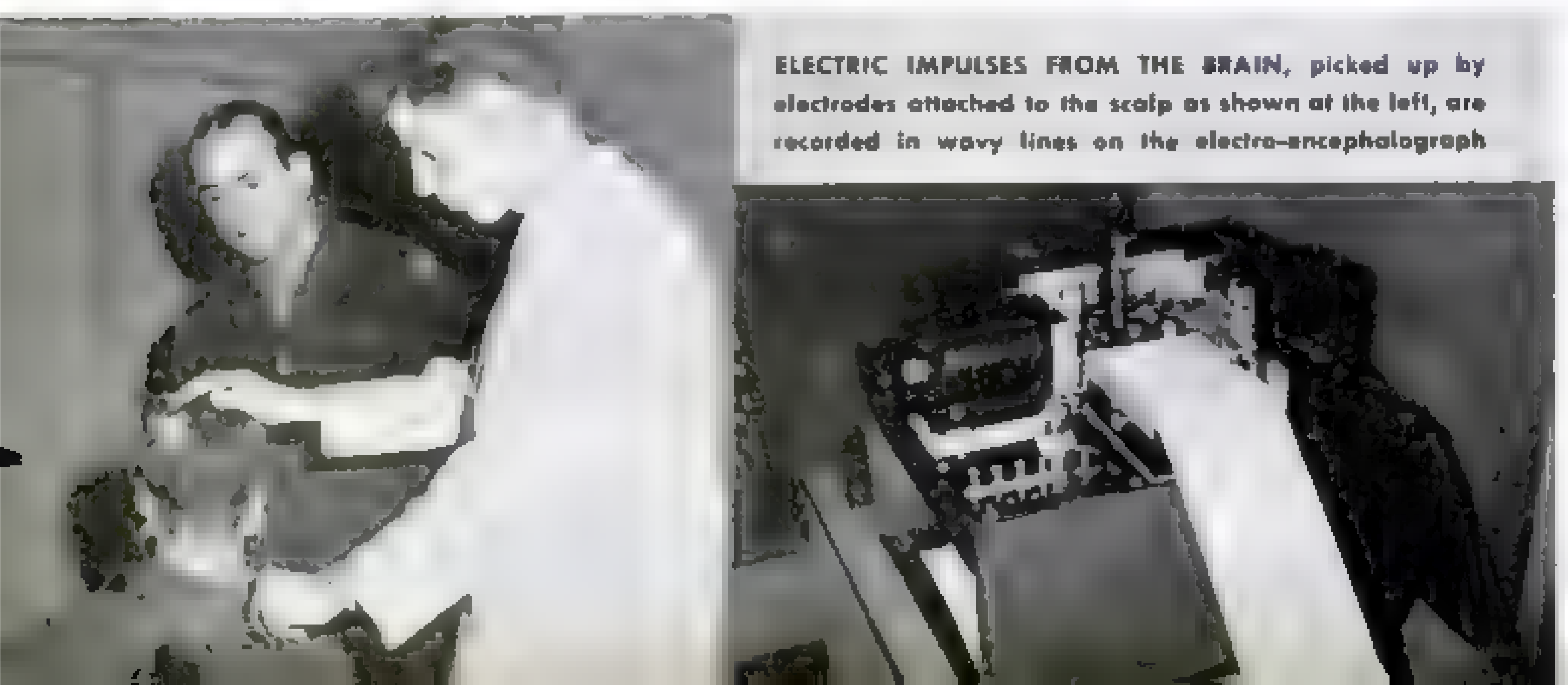
With the development of the modern science of nutrition, of which the vitamins are an important segment, we learned that one could be *not sick,* but at the same time *not healthy,* as in the case of "subclinical conditions," in which the patient is not *manifestly* ill, but also is far from well. We also discovered that susceptibility to many types of disease, including infections, was due to malnutrition, and that growth, development, and aging were profoundly influenced by the quantity and quality of the foods eaten.

As our knowledge of nutrition increases, and as that knowledge is applied to the everyday diet of people, we are bound to see a reduction in the incidence of disease, and an improvement in physical growth and well-being.

The Sex Hormones

The discovery of the sex hormones is one of the achievements of modern medicine on which the public is comparatively uninformed. Yet it is truly a tremendous accomplishment.

It was a bright hunch that led to the discovery of the female sex hormone. When an ovum (egg) ripens in the ovary, it is surrounded by a minute quantity of a yellowish fluid, known as the *liquor folliculi.* No one thought to investigate the function of that fluid until 1922, when Edgar Allen, Ph.D., of St. Louis, and his wife obtained buckets of ovaries from a meat-packing plant and, working on their kitchen table, carefully drew off the fluid from the follicles. Soon they had enough of it to enable their co-worker, Dr. E. A. Doisy, to purify it and determine its chemical constitution. This made possible the crystallization of the female hormone in 1929. In 1936 it was reproduced artificially. *(Continued on page 228)*



ELECTRIC IMPULSES FROM THE BRAIN, picked up by electrodes attached to the scalp as shown at the left, are recorded in wavy lines on the electro-encephalograph

"Bing" Helps Sing the Axis to Sleep

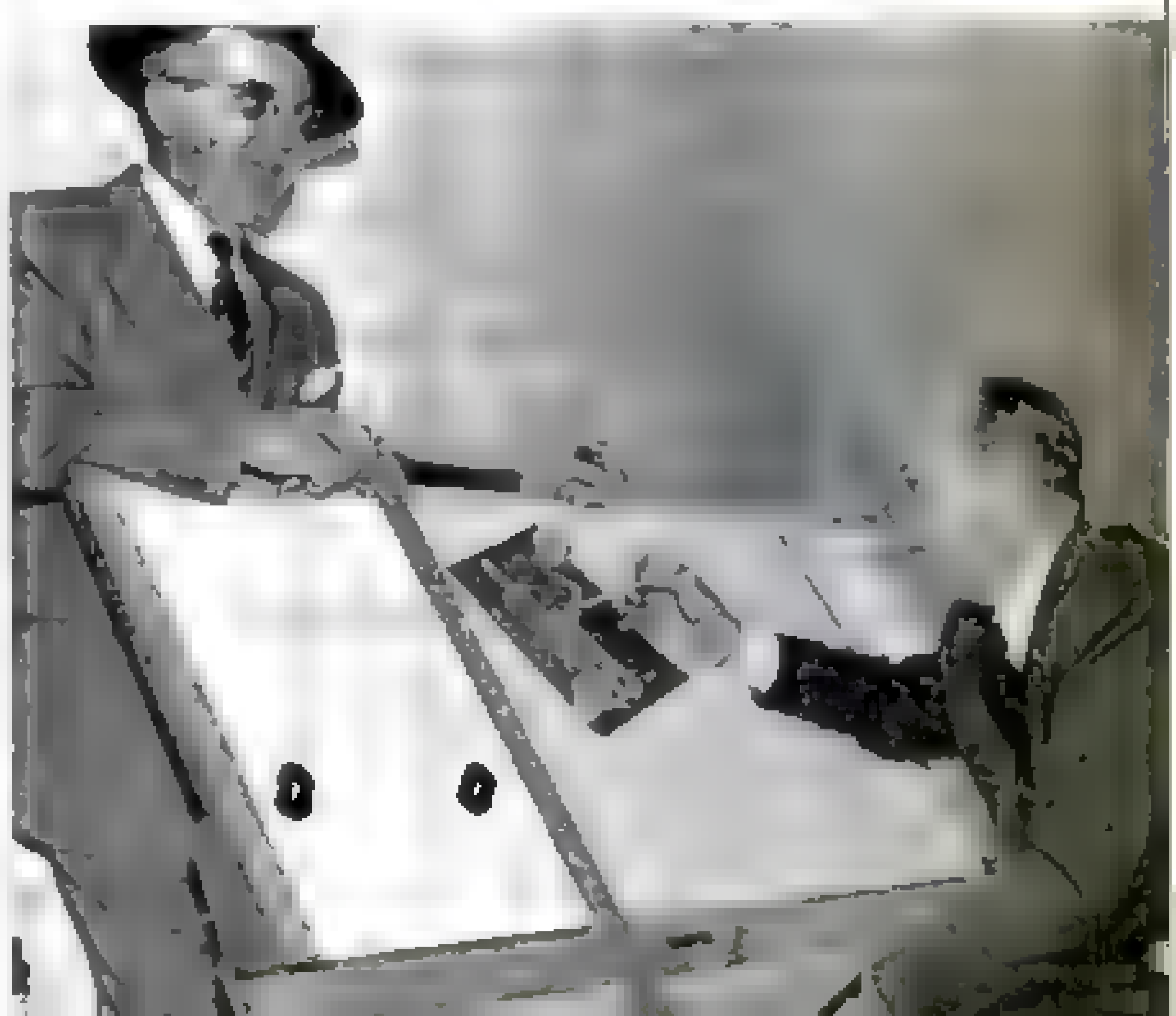
WITH THIS PORTABLE PUMP you can play a bucket of water onto a flame above. With the pipe bottom in the water, you merely point the nozzle and turn the crank. Rotation of an eccentric cam forces twin diaphragms outward, expelling water

"COMING Through... with What's New." It's the wartime duet of the Crosby brothers. No, they don't croon it; they swing it. As part of their contribution toward victory, Bing and Larry maintain the Crosby Research Foundation at Pasadena, Calif. The Crosby routine: develop inventions, get them into production, and then let Uncle Sam use them against the enemy. Ideas come in like fan mail—over 15,000 so far, and several, having passed the experts, are serving the armed forces. Most are secret, of course, but on this page are a few of those that can be told.

THIS SPRING SAVES BEARINGS. By absorbing misalignment, this flat-sided, semicircular spring keeps bearings in shape and their races in groove

A BLACKOUT LANTERN which casts no light upward is Crosby-developed to guard trenches. A louvered section, dropped by a trigger touch, releases light only through well-shielded slits

MAGNETS SERVE AS PAPERWEIGHTS on this plotting board, designed to aid navigators on storm-tossed ships or airplanes and draftsmen who have to work in the open. The board has a light sheet-iron core faced with plywood sheets ⅛ inch thick



Combat Engineers Take a River in Their Stride

How Tank-Carrying Bridges Are Built

By JACK O'BRINE

Photographs by WILLIAM W. MORRIS

AMERICAN Army combat engineers have a thumping surprise for enemy troops who think they can stymie pursuit by blowing up big bridges. It's their pride now to duplicate the carrying capacity of the huskiest span you ever saw in about the time it takes to see a double-feature movie show. When they've finished, our armor goes roaring over water that in another war might have taken weeks to cross. The engineers do it with rubber and steel and a remarkable new equipment carrier.

They're close at hand when the enemy retreats across a river and destroys the only bridge that can carry heavy traffic. Hardly has the wrecked span hit the water before they roll merrily out of camouflaged dispersal positions and go to work on the near shore. In recent maneuvers, the 22nd Armored Engineer Battalion built a 330-foot bridge in three hours and two minutes.

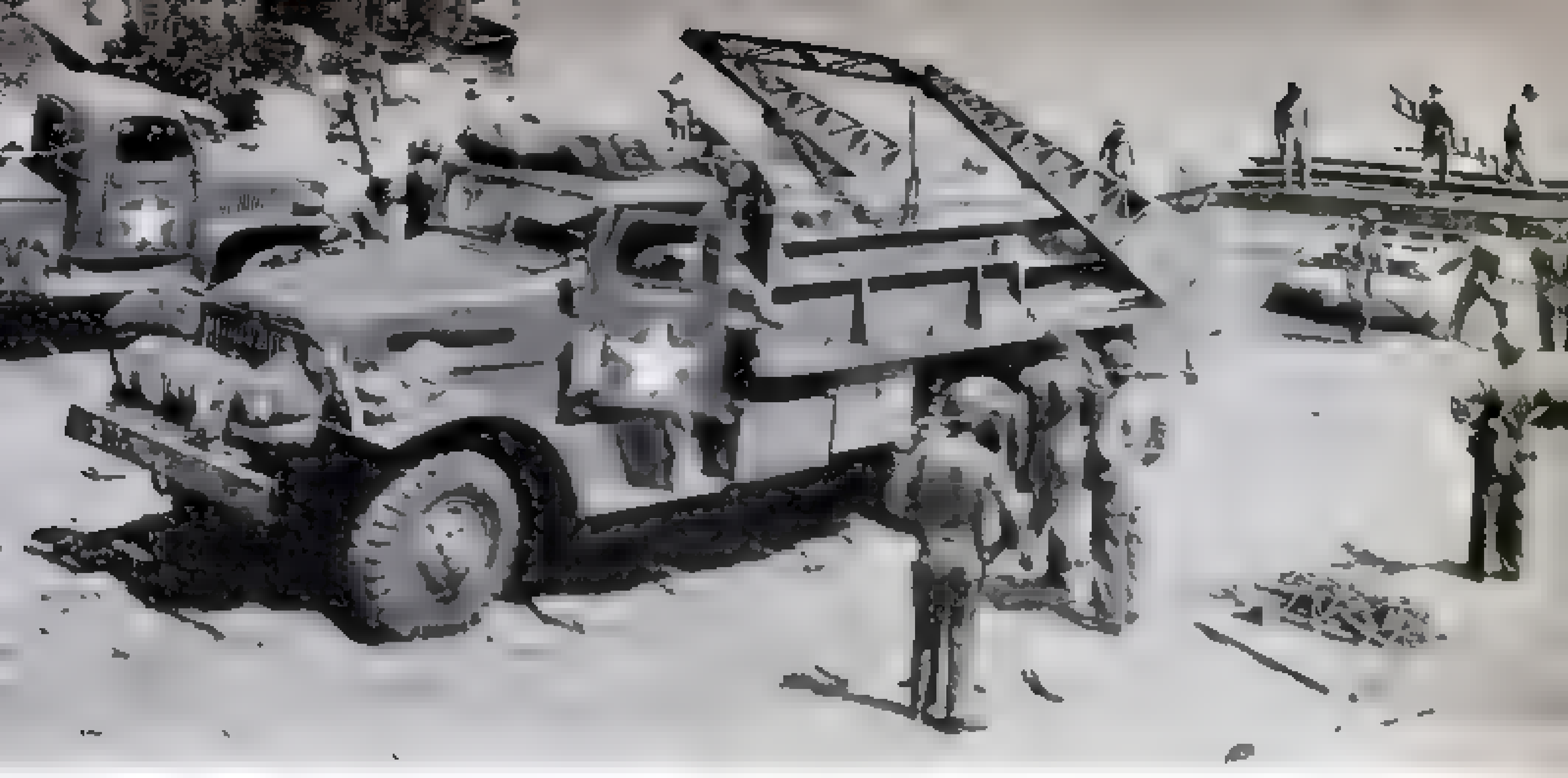
This amazing achievement means speedy crossings for heavy armor and much greater safety. Brought into use are longer, sturdier pontons, improved steel saddles, and wider treadways.

1 Arriving at the bridge site from a camouflaged dispersal position, a Brockway is backed into working location on the river bank, and soldiers prepare to lower the big pontons, which are wrapped in heavy canvas to protect the rubber from damage by the sun. On the ground . . .

2 . . . the cover comes off and the deflated ponton is unrolled to its full length. Valves are opened for a mobile air compressor to pump up the bag

5 . . . and the hydraulic crane swings into action to unload the steel saddles and treadways. With this magic "elbow," two men can do what once required eight

6 A "butterfly" attached to either end of the steel saddle makes it reach the full length of the ponton for better balance. Note how the joints telescope



THE TRUCK: One secret of the combat engineers' speed in building ponton bridges is the new self-unloading Brockway six-by-six equipment carrier. Each holds material for 30 feet of bridge, including two pontons, two steel saddles, and four treadways. Loaded, it weighs 26 tons, but is fast and easy to handle

3 It takes a lot of wind to fill the big, oblong doughnut, which is 33 feet long and 32 inches in diameter. Its 16 separate air cells keep it afloat under strafing attacks

4 About five minutes after inflation starts the ponton is bulging with air and ready to take the water. Engineers carry it gingerly to keep sharp rocks from puncturing the compartments. Meanwhile, the Brockway backs to the water's edge . . .

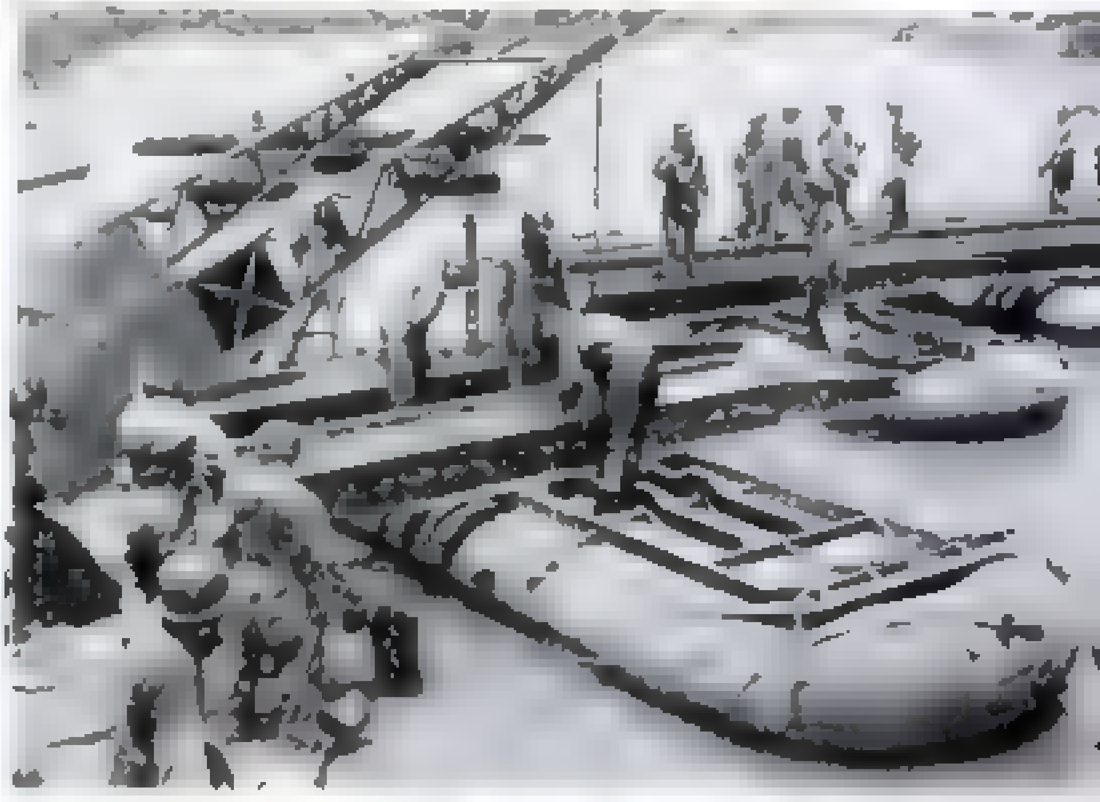
7 An Army boot kicks the clamp that locks the "butterfly" to the center section of the saddle. There are four of these clamps on each saddle, plus lock pins

8 Fastened together and strengthened with two I beams running down the center, the saddle is picked up by a hook for hoisting onto its ponton (CONTINUED)

9 Out onto the waiting ponton goes the assembled saddle. It is lifted by a boom type crane mounted on a 13-ton Coleman truck. Operated from a carrying cab, this crane helps out the Brockway

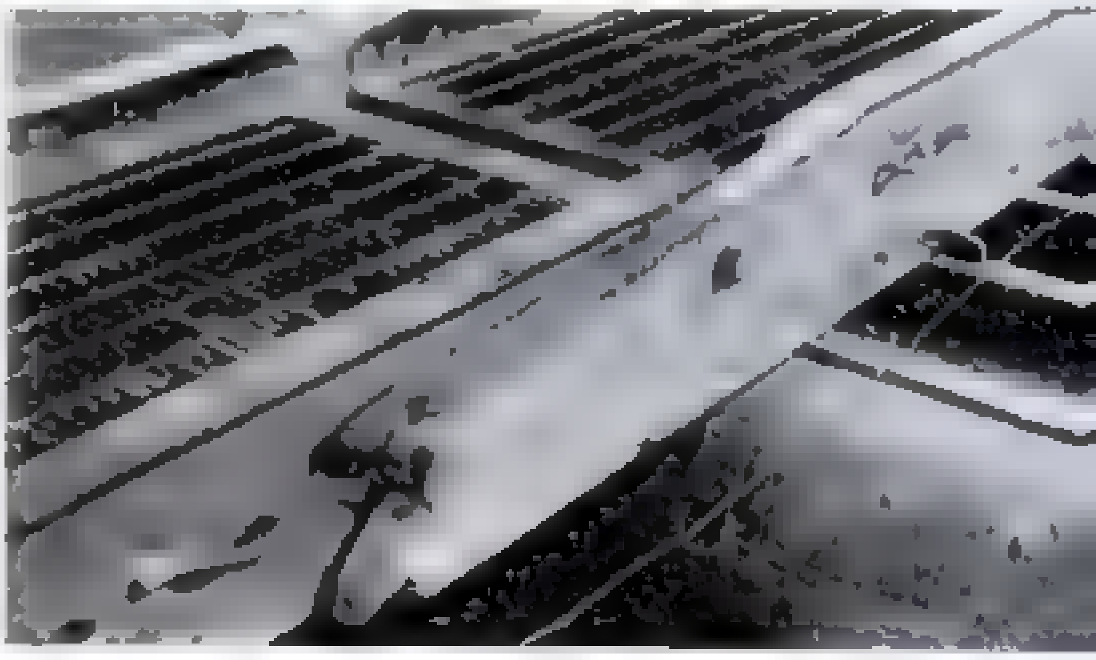
10 In place on the ponton the saddle is secured by buckles at four foot intervals to keep it from shifting under a load

11 Now the Brockway moves in close to unload the perforated steel treadways, which are 15 feet long with high guard rails outside the two foot-wide surface



12 Treadway sections are laid crosswise over the center part of the ponton saddle to make a 15-foot length of bridge. Markings insure perfect balance

13 Completed ponton sections are now aligned and the overlapping treadways are bolted together. Here engineers shove home one of the big pins . . .



14 . . . which extend for the full width of the treadways. Two pins in each joint give rigidity. This view shows perforated tread for traction in wet weather

15 When three sections—45 feet of bridge—have been joined, they are ferried across the river with an assault boat. Jeep and bulldozer ride first trip

16 Working back from the far shore, engineers join three ponton sections. This method leaves the near bank clear for the work of assembling more pontons

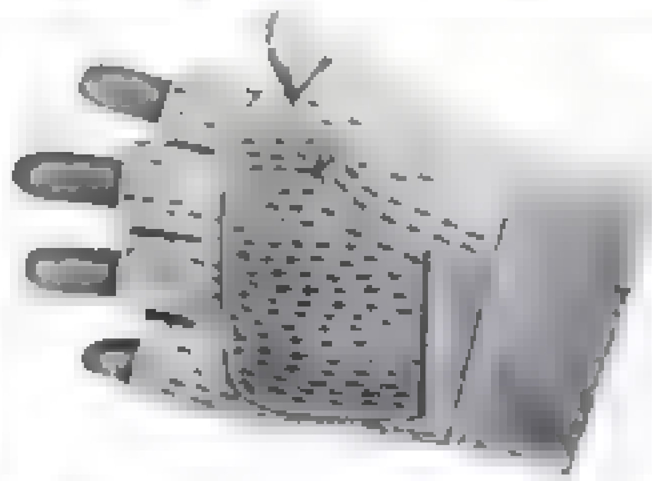
17 As the last ponton is shoved into place, a signal man rolls a reel of telephone wire across to set up communications for traffic control and other purposes

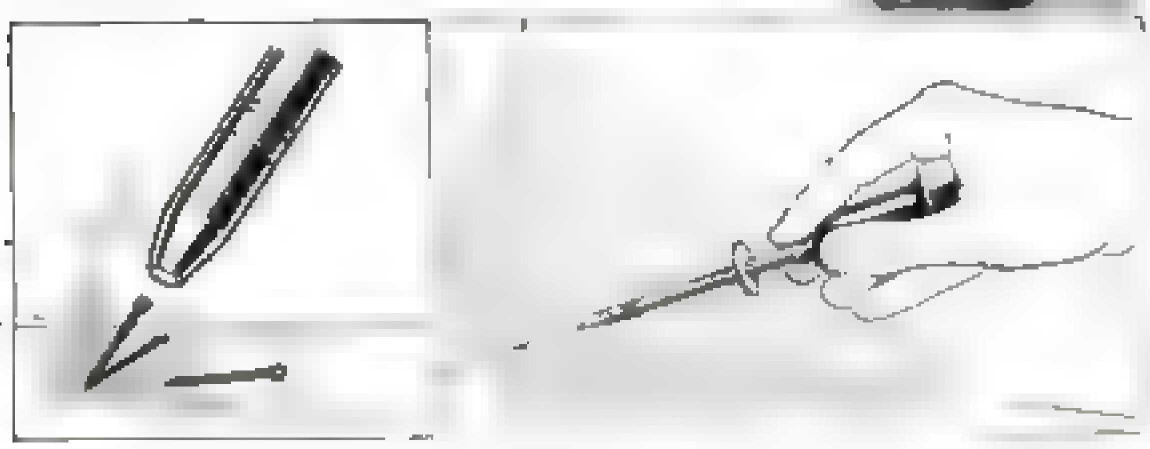
18 To brace the bridge against the river current, 200-pound catch anchors are dropped from assault boats some 50 yards upstream. About a dozen are used

19 Just three hours and two minutes after the engineers started work, heavy traffic begins to roll across the bridge. Fighter planes that guarded the builders stay on the job to protect the span. Upstream, interlocking assault boats form a screen against drifting mines. Thanks to combat engineers, this river won't stop pursuit of the enemy

new Tools

ETCHING on metal from a pattern of lettering or design is made possible by an electric-arc etcher manufactured by the George Gorton Machine Co., Racine, Wis. Using the pantograph principle to reproduce designs, the etcher operates at a speed of 120 arcs a second





STEEL-RIBBED GLOVES without finger or thumb tips are now manufactured by Industrial Gloves Co., Danville, Ill., for use by workers handling heavy metal pieces. The tipless feature gives more flexibility and permits finger-testing of materials.

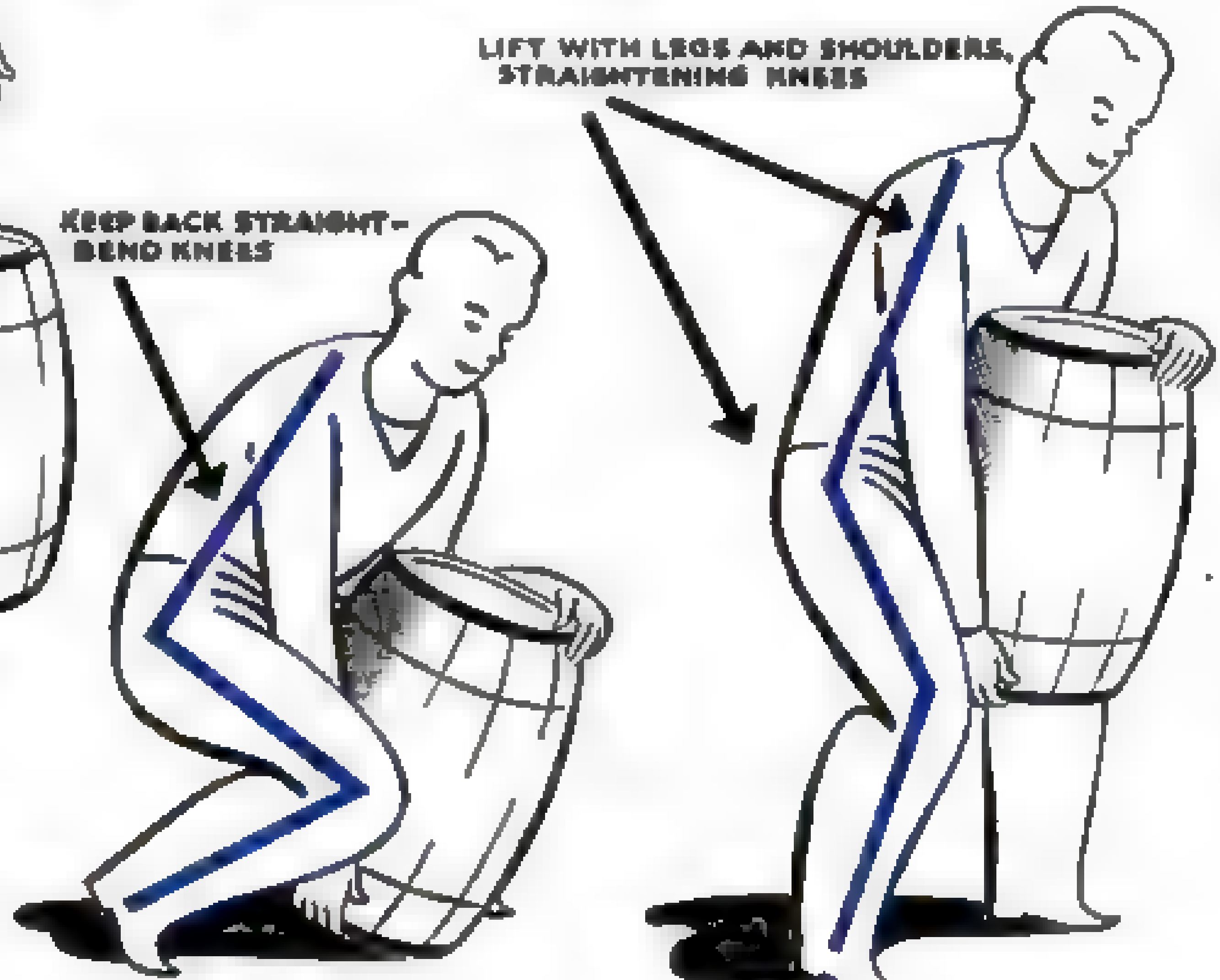
MAGNETIC BRAD DRIVER. Product of the Markwell Manufacturing Co., of New York, this handy magnetized tool makes it easy to pick up a brad and drive it into a corner where it cannot be conveniently hammered; its magnetic tip also aids in selecting the proper brad. The tool is 6¾ inches long.

MOISTURE CONTENT of a material can be measured by placing this gauge's contact on the material to get an electrical-resistance reading. By comparison readings on built-in calibrated moisture standards, moisture content of original material is determined. Manufacturer is Hart Moisture Gauges, Inc., New York.

Don't Lift Yourself Into Trouble

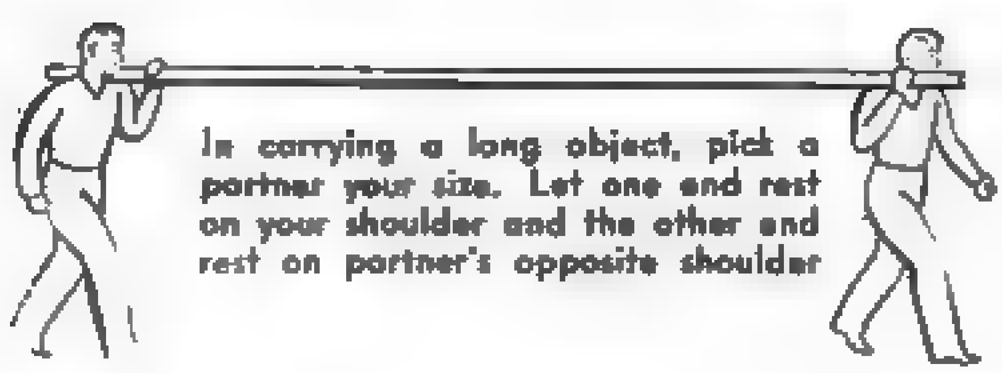
HOW TO AVOID INJURY FROM HEAVY LOADS

ONE quarter of all industrial accidents are said to be caused by people not knowing how to lift heavy objects. Often the injuries are serious: a hernia, a strained abdominal muscle, or a wrenched back that may lay up a person for weeks. In lifting a heavy load, get as close to it as you can and then place your feet so that the distance between them is about the length of your shoe. If you have to get down low, keep your back straight and bend your knees. Never bend from the waist and try to lift something with just your arms. Once you have a good grip, start coming up slowly. Don't try to lift suddenly. Now raise the load so that the pull is on your thigh and shoulder muscles.



SUGGESTIONS. Carry all loads close to your body and as near your center of balance as possible. Be sure that you can see where you are going. Try to arrange the load so that it will not interfere too much with your natural manner of walking

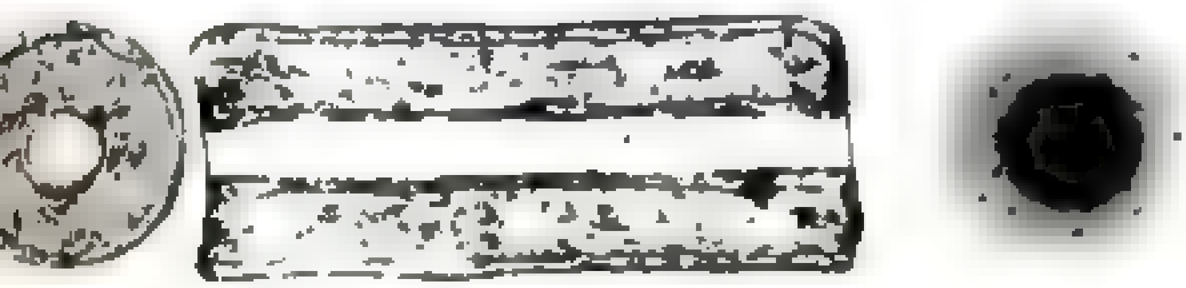
SAFETY. If a load is very heavy, don't try to show off—get a helper. Make sure you have a steady, firm footing, and that the load and your hands are not slippery. If you work with a partner, decide beforehand which one is to give the orders



In carrying a long object, pick a partner your size. Let one end rest on your shoulder and the other end rest on partner's opposite shoulder

On an endless belt, "ball powder" is dried under this battery of infrared lamps in the plant of the Western Cartridge Company

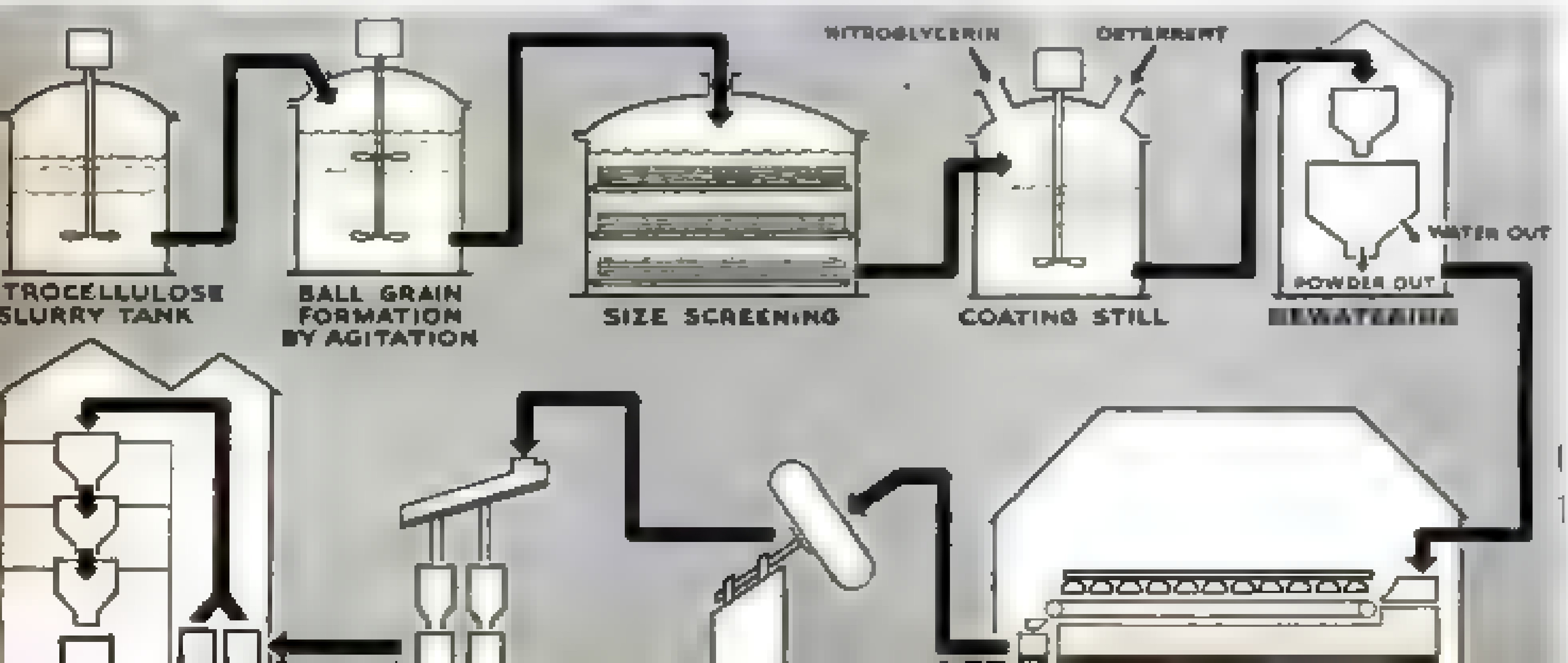
Coated with graphite in the doughnut-shaped rotor below, powder pellets are made easier to pour and immune to static electricity



Ordinary smokeless powder comes in macaroni shape, as shown in the magnified transverse and lengthwise sections at left and center, above. A granule of the new ball powder, sliced in two and magnified 30 times, appears at upper right. Pictorial flow chart below shows the process by which the new explosive is made

New Powder Passes the Ammunition —Faster!

THANKS to a rusty pipe, production of smokeless powder for Allied machine-gun and rifle cartridges has been speeded up 500 percent. Preparing the main ingredient, nitrocellulose, formerly required 100 hours' washing with boiling water to remove traces of acid. Using this method as a "control test" for comparison, Dr. Fred Olsen, Western Cartridge Company technician, vainly sought a chemical short cut, until he ran out of distilled water and used tap water instead. Next day he found that rust from the pipe had made the control test successful. Behaving like a dye, it hung onto the nitrocellulose while the acid vanished. Hunting more effective dyes, Dr. Olsen tinted nitrocellulose every hue of the rainbow, but found the best chemical a colorless dyestuff called diphenylamine. Besides reducing washing time, it produced a better-keeping product than ever before. Offshoots of the discovery led to use of ethyl acetate, widely used in nail polish, to make creamy bubbles of nitrocellulose; and recovery of the washed powder in the new form of tiny spherical pellets resembling miniature BB shot. Drying takes place under a battery of infrared lamps, so adjusted that the rays penetrate the powder. Then a rotor coats the powder with graphite, just as the drugmaker's "sweetie barrel" coats bitter pills.



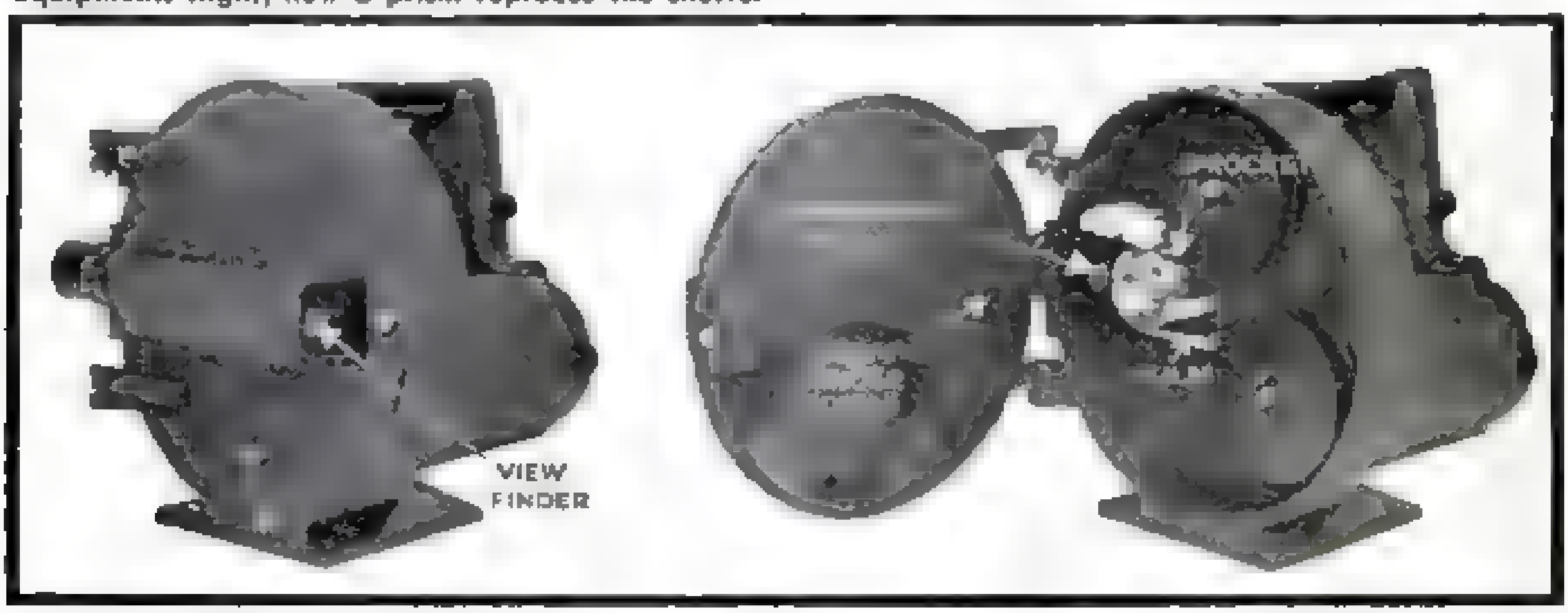
Exposure: 83 millionths of a second

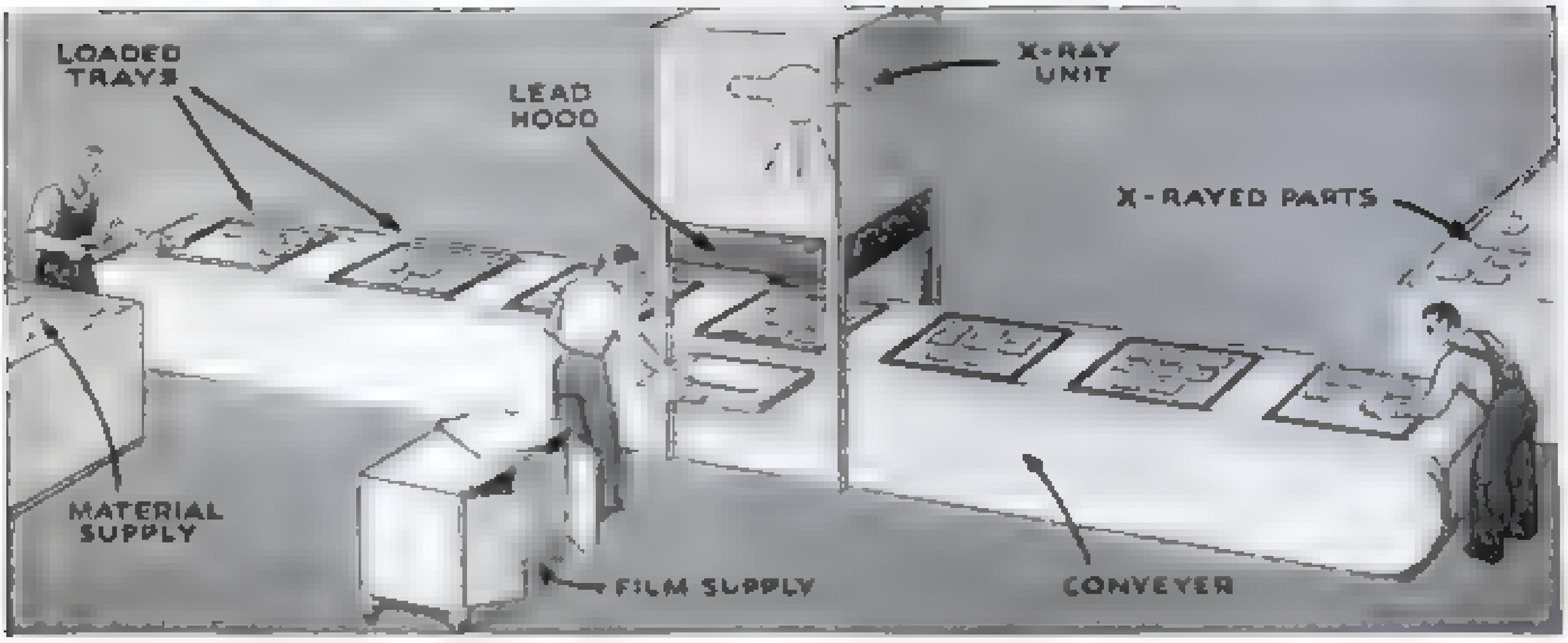
THIS IS WHAT HAPPENS WHEN AN ORDINARY HOUSE FUSE BLOWS

8,000 Pictures A Second

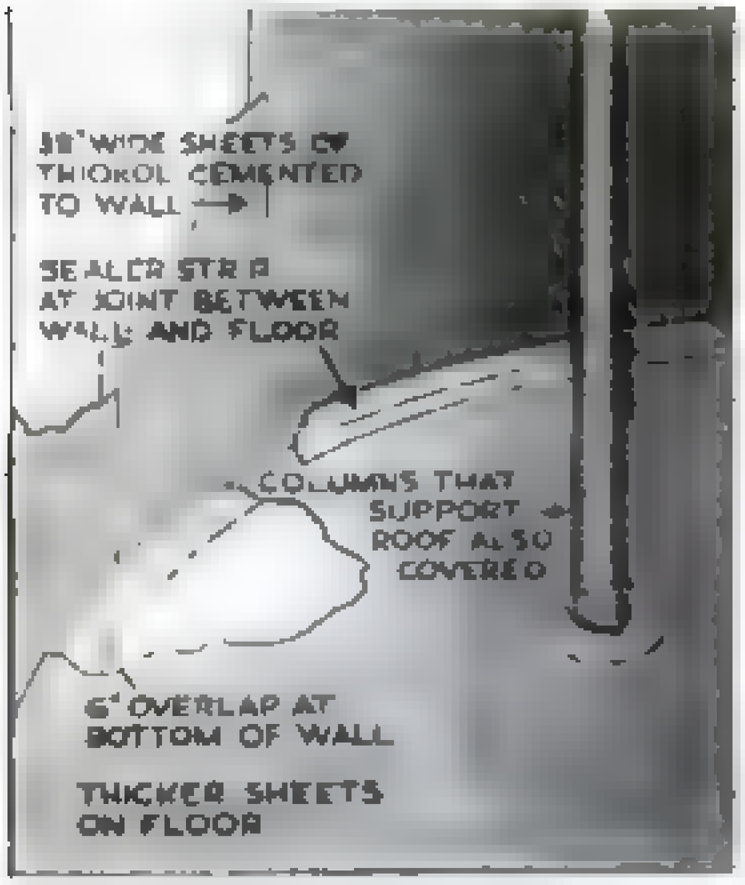
Fastax camera set up to study action of electrical equipment. Right, how a prism replaces the shutter

EXPOSURES of as little as 1/30,000 of a second are made possible by a high-speed motion-picture camera designed by Bell Laboratories and manufactured by Western Electric for use in analyzing fast motion. Film racing at 70 miles an hour is exposed by means of a prism with opposite faces parallel, revolving 60,000 times a second, instead of the usual shutter



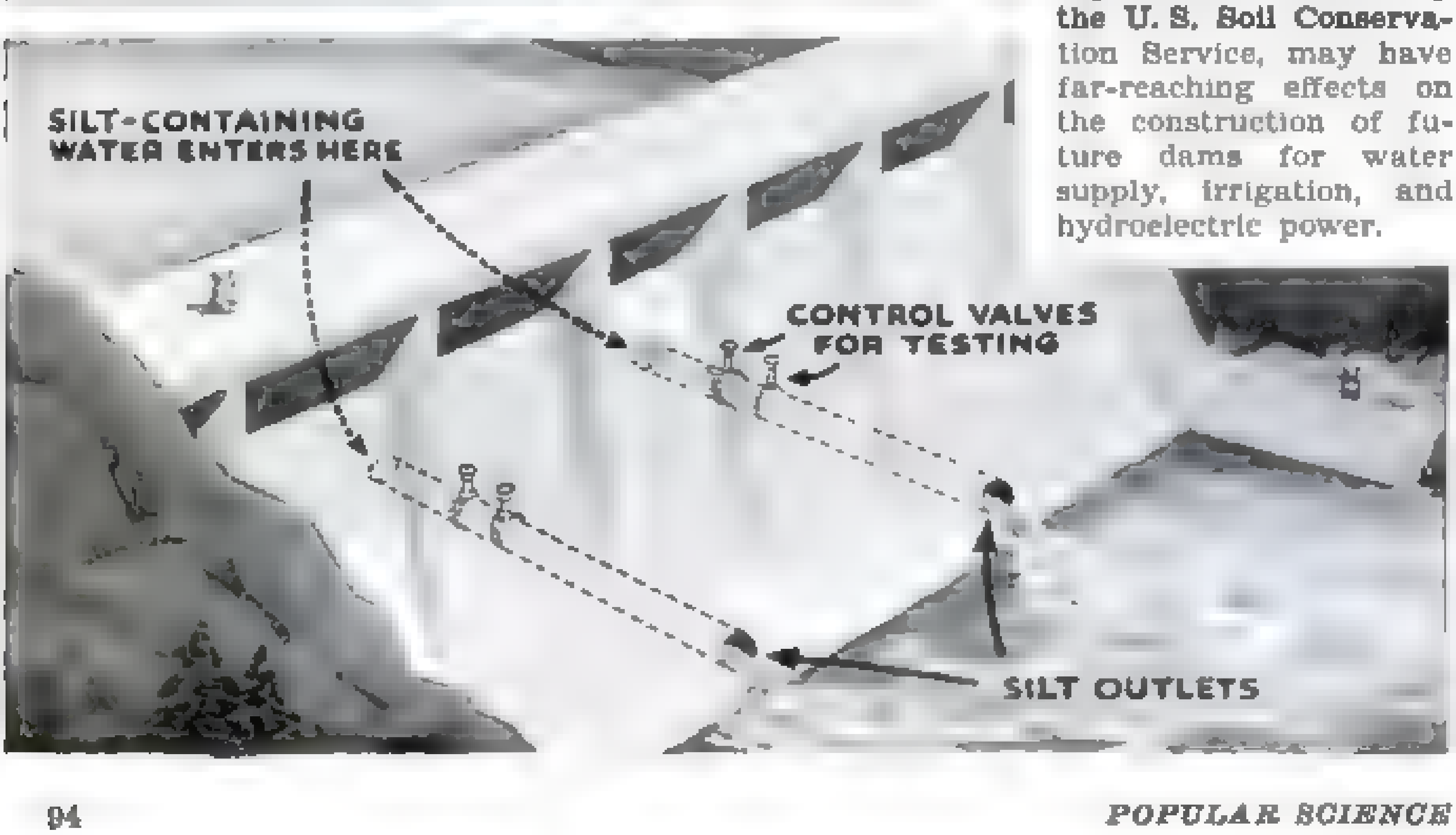


MASS-PRODUCTION X-RAYING of airplane parts is made possible by a machine developed by Westinghouse. A 40-foot conveyor carries castings on trays under two steel towers housing the X-ray tubes. Every 30 seconds the unit produces an exposed film of six castings; as many as 17,000 castings can be inspected in a 24-hour day.



GASOLINE STORAGE TANKS are being built for the U. S. Navy of reinforced concrete lined with Thiokol FA synthetic rubber. Walls, floors, supporting columns, and other interior parts of the tanks are "papered" with thin, specially prepared sheets of the material, which not only prevents seepage but also protects the fuel against gum formation and loss of octane rating through contact with alkalies in the concrete.

SILT VENTS built into the dam of the Brighton Reservoir, on the Patuxent River in Maryland, will carry off the sedimentation which otherwise would accumulate gradually and reduce the capacity of the artificial lake. Sampling pipes and faucets in the five vents will make it possible to vary the flow according to the amount of silt being brought down by subsurface currents. The experiment, fostered by the U. S. Soil Conservation Service, may have far-reaching effects on the construction of future dams for water supply, irrigation, and hydroelectric power.



Fast freighters like this, 525 feet long and 70 feet in beam, will help America to retain her place as a great maritime nation. Sustained speeds of 18 to 20 knots will be furnished by 15,000-hp. Diesel engines. Ventilation, with the stack carrying the exhaust, will keep cargoes in good condition

Ships for the Seas of Peace

By CAPT. W. MACK ANGAS (C.E.C.) U.S.N.

Drawings by STEWART ROUSE

Opinions expressed in the following article are the author's. They should not be interpreted as those of any branch or department of the Government.

ALONG with being the leading industrial power at the close of the war, the United States will also be a great maritime nation. With a fleet of medium-sized cargo vessels, tankers, and cabin liners as fine as or finer than any others afloat, our early postwar merchant fleet will lack only express superliners and will be fitted to carry its share of trade in the first days of peace.

To remain a great maritime nation, however, we must be prepared to construct improved vessels when science and industry return to normal. At that time materials and techniques that have been devoted to the war will enable shipbuilders to turn out vessels far surpassing those now in existence.

The most spectacular and highly publicized merchant ships are the express superliners, and if transocean planes do not take too much of their trade, larger and faster ones will be built. Those operated before the war were of over 50,000 tons. Their speed, averaging 28 knots on a crossing, made it possible to maintain weekly service between New York and Europe with two ships.

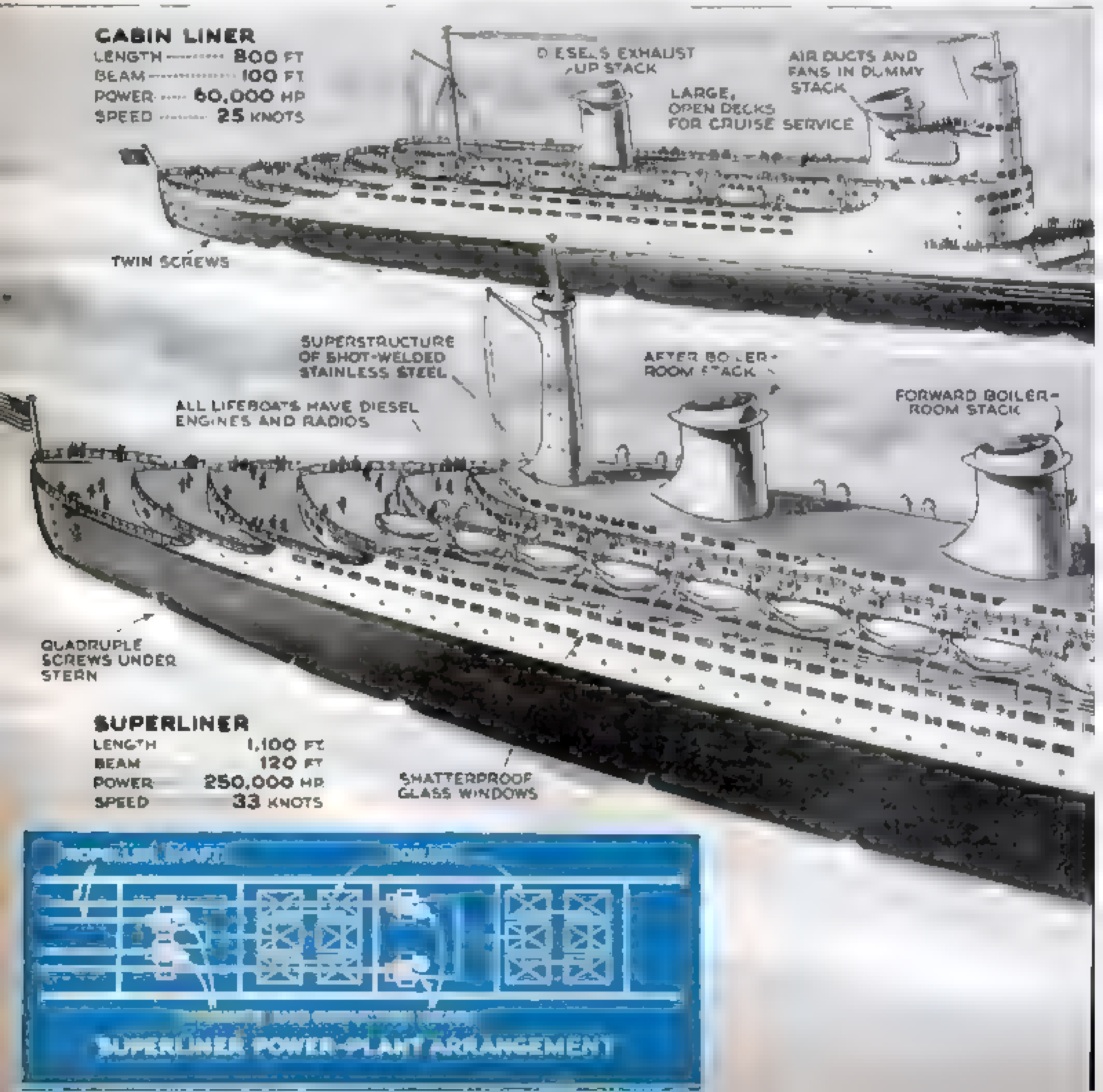
Postwar superliners will be still faster, but probably will not exceed 32 or 33 knots, although it is estimated that 35 knots could

be used advantageously to allow longer periods for victualing, fueling, and cleaning ship. Over-all length will be kept to 1,100 feet and beam to 120 feet by channel, terminal, and docking limitations.

Propulsion will almost undoubtedly be by quadruple screws driven by geared turbines. Pressures as high as 1,200 pounds are likely, and steam temperatures may be raised by superheating to as much as 900 degrees Fahrenheit. Also possible are geared Diesel engines, Diesel-electric drive, and the recently developed mercury-steam turbo-electric system.

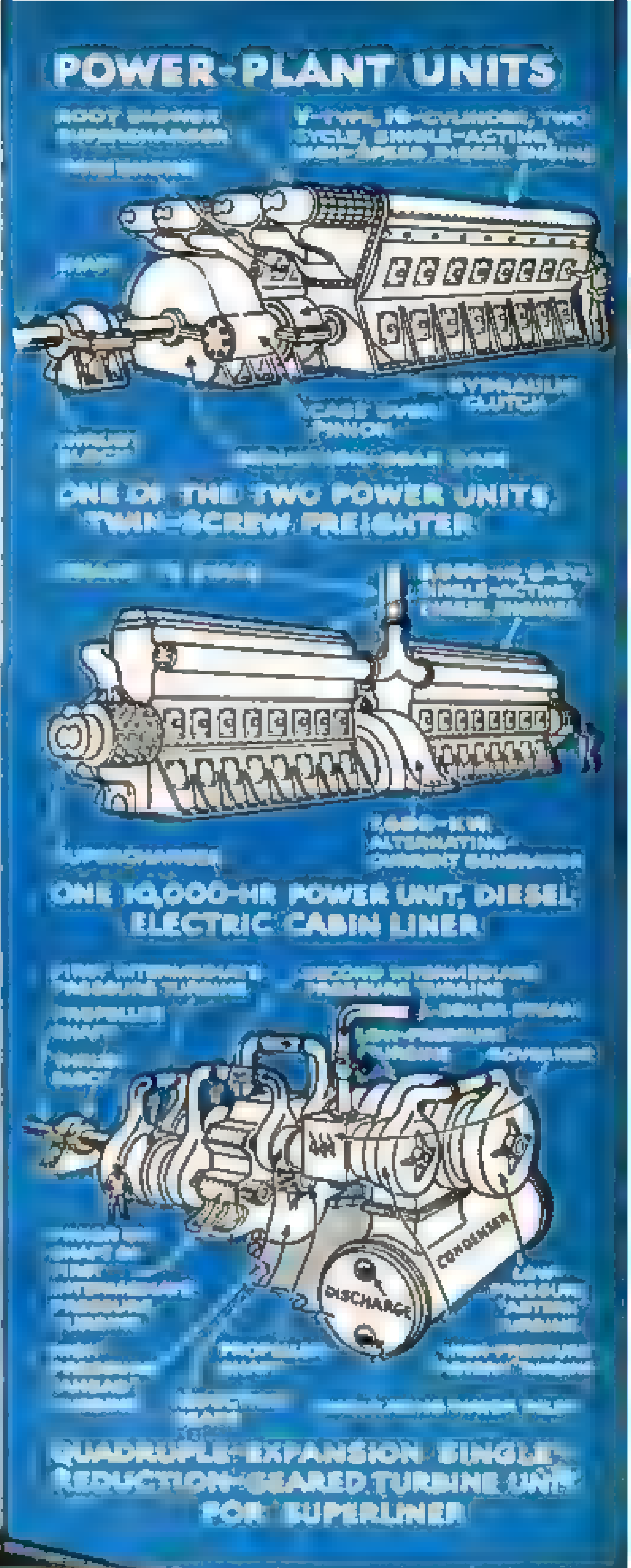
Cabin liners will suffer much less from air competition. Larger and more comfortable than even the finest of the prewar ships of this type, they will probably have a length of 800 feet or more, with docking facilities in many of the cruise ports visited in the "off season" of the North Atlantic service. The power plant needed for their maximum speed of 24 or 25 knots will perhaps not exceed 60,000 or 70,000 horsepower, and their normal sea speed of 21 or 22 knots will be sustained with considerably less. For this, geared Diesel engines and Diesel-electric drive are much more probable than for the huge power outputs required for a superliner capable of over 30 knots.

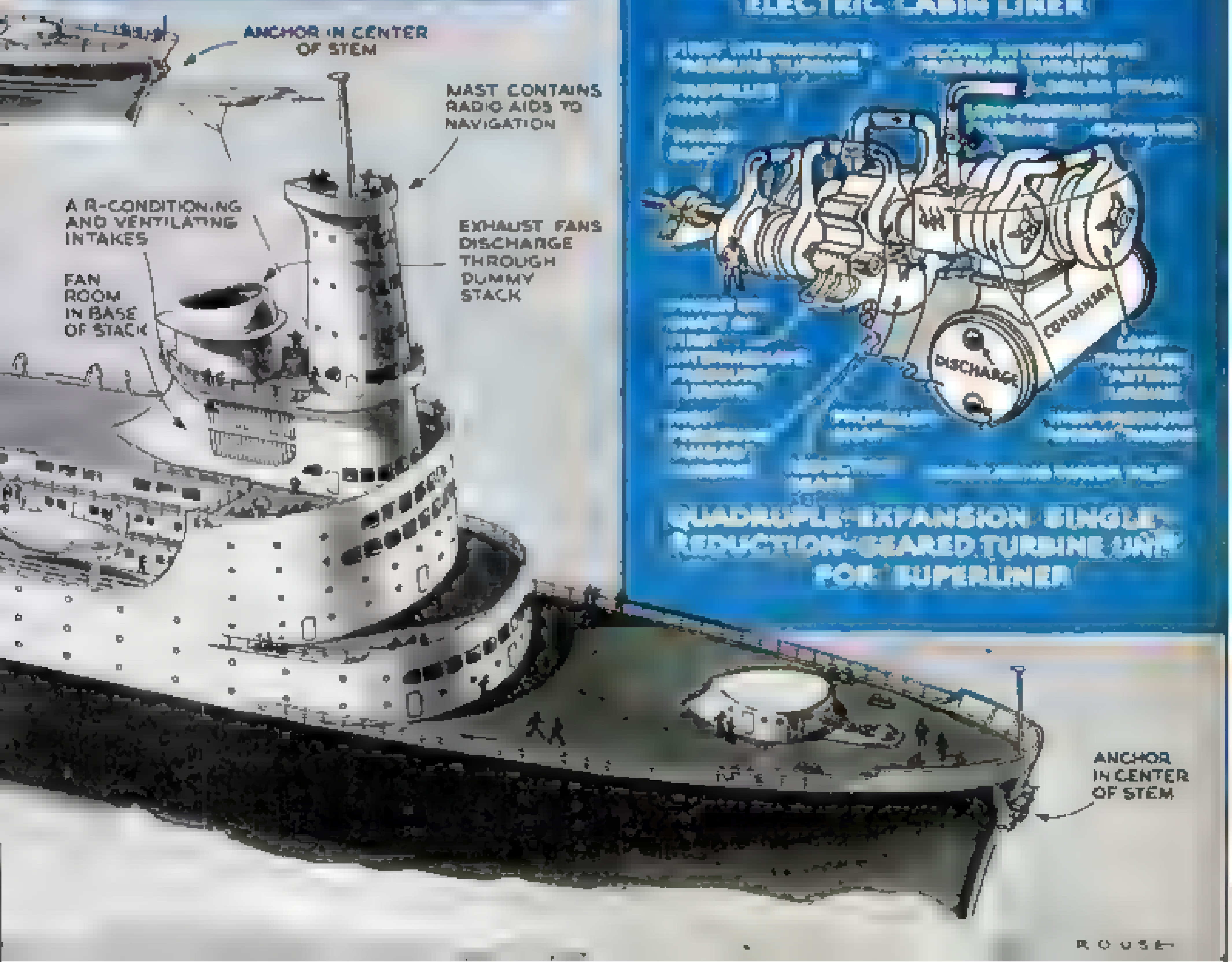
By far the most important merchant ships are freighters. The finest yet produced are possibly the handsome and able C-3 ships of the United States Maritime Commission, and new ones will be in all likelihood a development of this type. World-

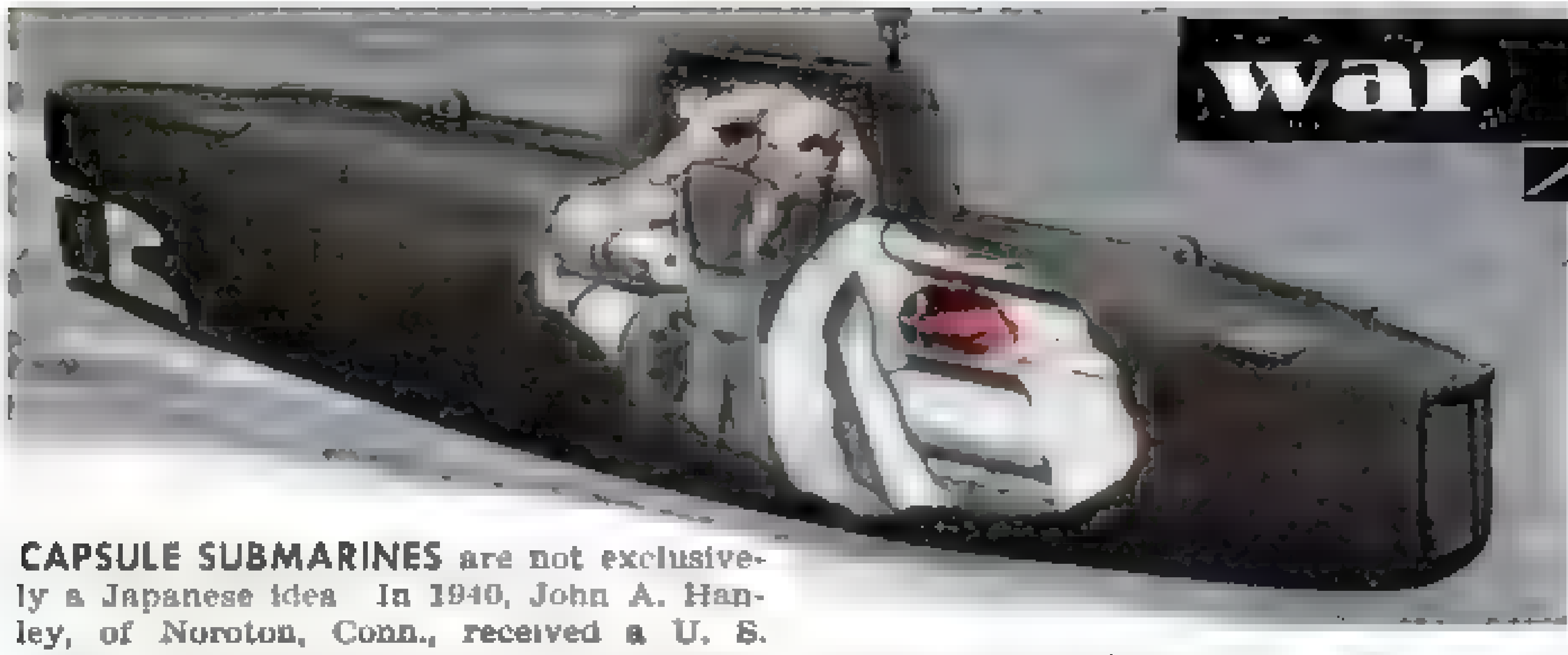


wide war improvements to channel, harbor terminal, and docking facilities will permit lengths of 500 or even 525 feet. Sustained speeds as high as 18 or 20 knots may be expected.

Geared Diesel engines of about 15,000 total horsepower driving twin screws will probably propel the majority of these freighters, though undoubtedly some will employ high-pressure steam plants, and the internal-combustion, or "gas," turbine in conjunction with electric transmission is a possibility. It is also likely that the slightly higher efficiency of the single screw in ships of moderate size may lead to its utilization in services where the greater reliability and shallower draft made possible by twin screws are not necessary.

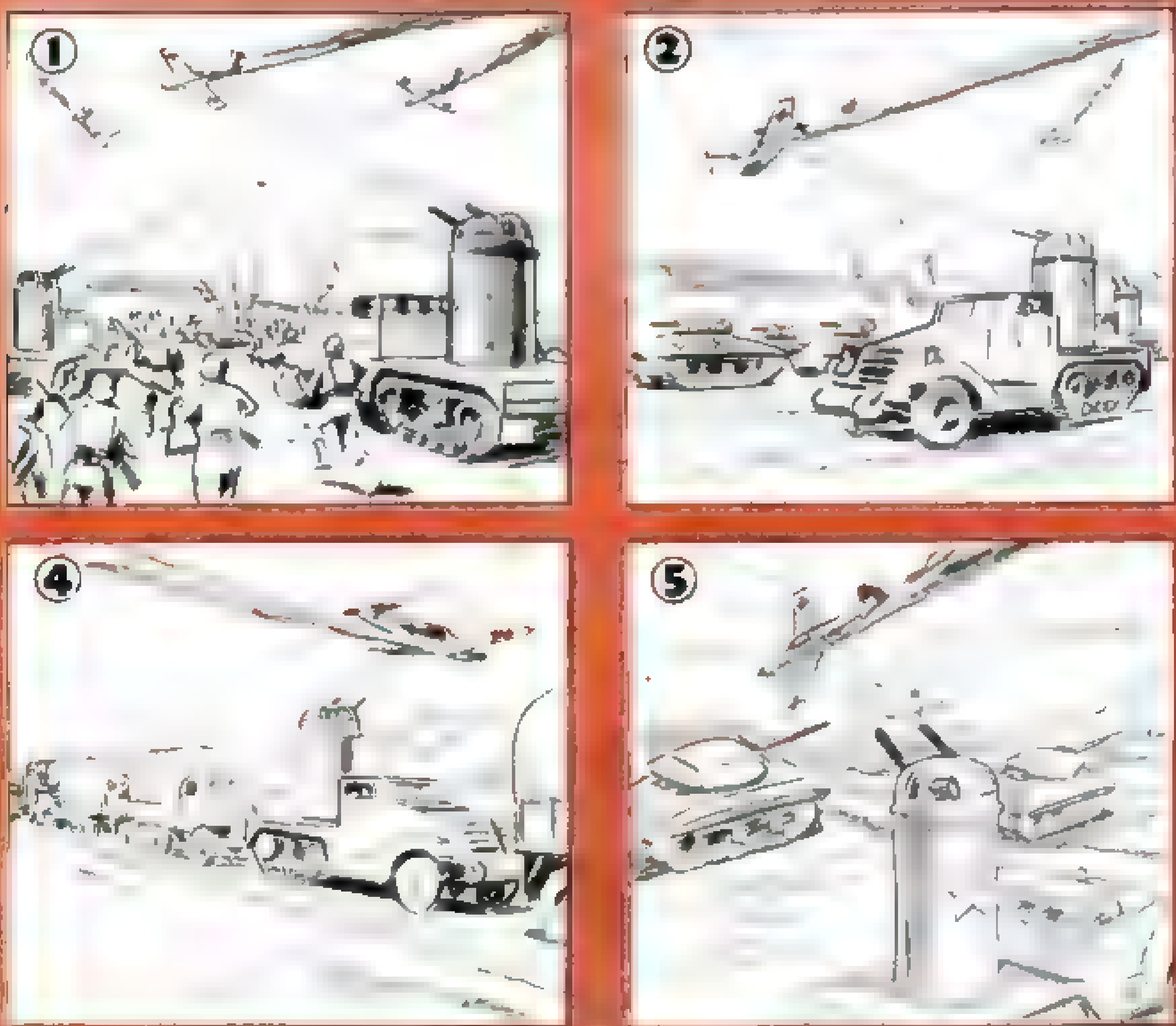




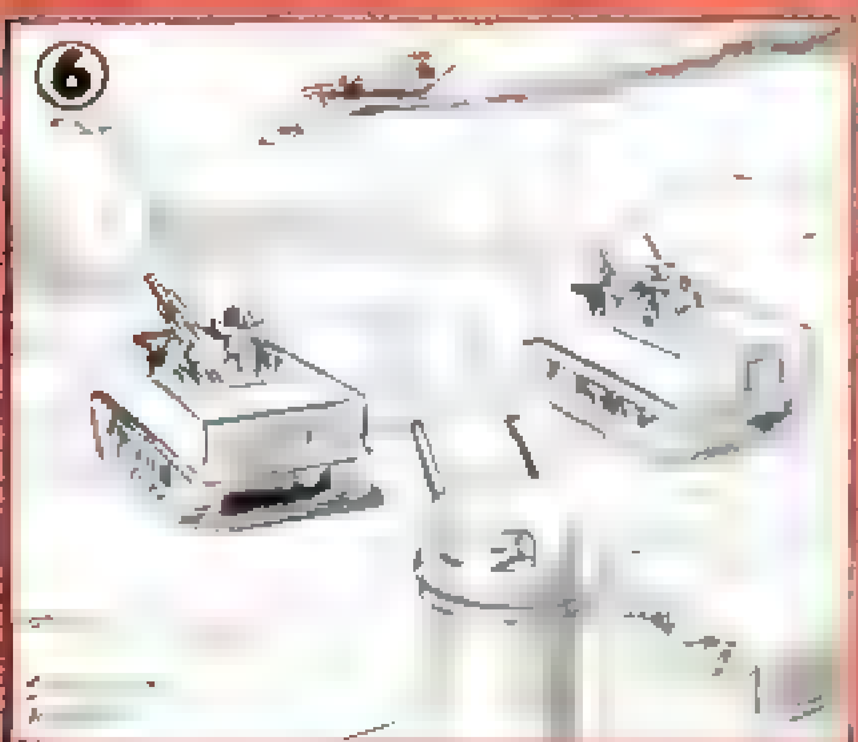


CAPSULE SUBMARINES are not exclusively a Japanese idea. In 1940, John A. Hanley, of Noroton, Conn., received a U. S. patent on the design of a six-ton undersea craft, which would be operated by two or three men and would carry two full-sized torpedoes. Powered only by batteries, the pocket sub would have limited range, being carried close to the scene of action by a larger vessel, to which it would return after performing its mission.

POWER TURRETS like those of big bombers, mounted on half-track trucks and equipped with automatic lead-computing sights (P.S.M., Nov. '43, p. 112), are proposed for the defense of ground forces against low-flying planes. Below are shown six ways in which the suggested self-propelled AA weapons might be used: 1. Putting up an umbrella of fire over advancing infantry. 2. Knocking down cannon-carrying planes and dive bombers attacking medium tanks. 3. Grouped around railheads and bridges to prevent dive-bombing and strafing. 4. Traveling in convoy



with trucks to destroy attacking enemy aircraft. 5. Defending tank-destroyer units against dive bombers and cannon planes. 6. Giving AA protection to armored field-artillery units. The turrets would be armed with .50 caliber aircraft machine guns mounted as they are in a plane



PARATROOPERS may find it easier to hit their ground targets through use of a device invented by G. G. Coleman, of Greenville, Miss. It is a wide, scooplike tail attached to the chute's edge, which the chutist can manipulate by shroud lines to guide his descent. Coleman's parachute also is strengthened by bias-cut silk panels.

FIRE aboard Navy PT boats is being fought by a system developed by Walter Kidde & Co., of New York. It includes shatterproof cylinders of liquid carbon-dioxide gas piped to nozzles above the engines, where most fires start. Remote-control valves are operated from the helm, with an auxiliary release outside the engine compartment.

Flying Plywood

The Mosquito, Britain's wonder fighter-bomber, is a termite's dream but a real nightmare to the German flyers whose fields it terrorizes around the clock.

By WILLIAM S. FRIEDMAN

Drawings by DOUGLAS ROLFE

THE massive aerial assault against Berlin did not come without warning. Many months before it was launched, the Nazi capital had a grim hint of what was to come —a hint delivered by the unpredictable, whiplash attacks of the light British Mosquito bomber, the unconventional plywood airplane which British enthusiasts have flatly called "the world's fastest aircraft."

In the days when the Allies were patiently building up their heavy-bomber power, Mosquitoes first streaked over the heart of the Reich to carry out surprise raids. Then, as the time drew near when major attacks on Berlin could be mounted, they harassed Central Germany with systematic attacks, keeping the antiaircraft and fighter-plane defenses in a state of continuous, exhausting alert and bruising the morale of the industrial city-dwellers.

When Allied heavy bombers struck their first blow, paralyzing Berlin in one crowded hour with 2,000 tons of bombs, Mosquitoes raced back next day to follow up their mission with more destruction and disorganization. However, the acute warning of the Mosquitoes' stinging powers came more than a year ago, when bombers of this type raided Berlin during the pompous celebration of the tenth anniversary of the Nazis' rise to power. This audacious attack and the many that followed showed the Germans the plane's unpleasant habits. They learned that it was a sleek, twin-engined attack bomber, which usually popped in from nowhere at very low altitude, dropped full-ton loads of delayed-action bombs on rail junctions, tool factories, and other key targets, then disappeared with ease.

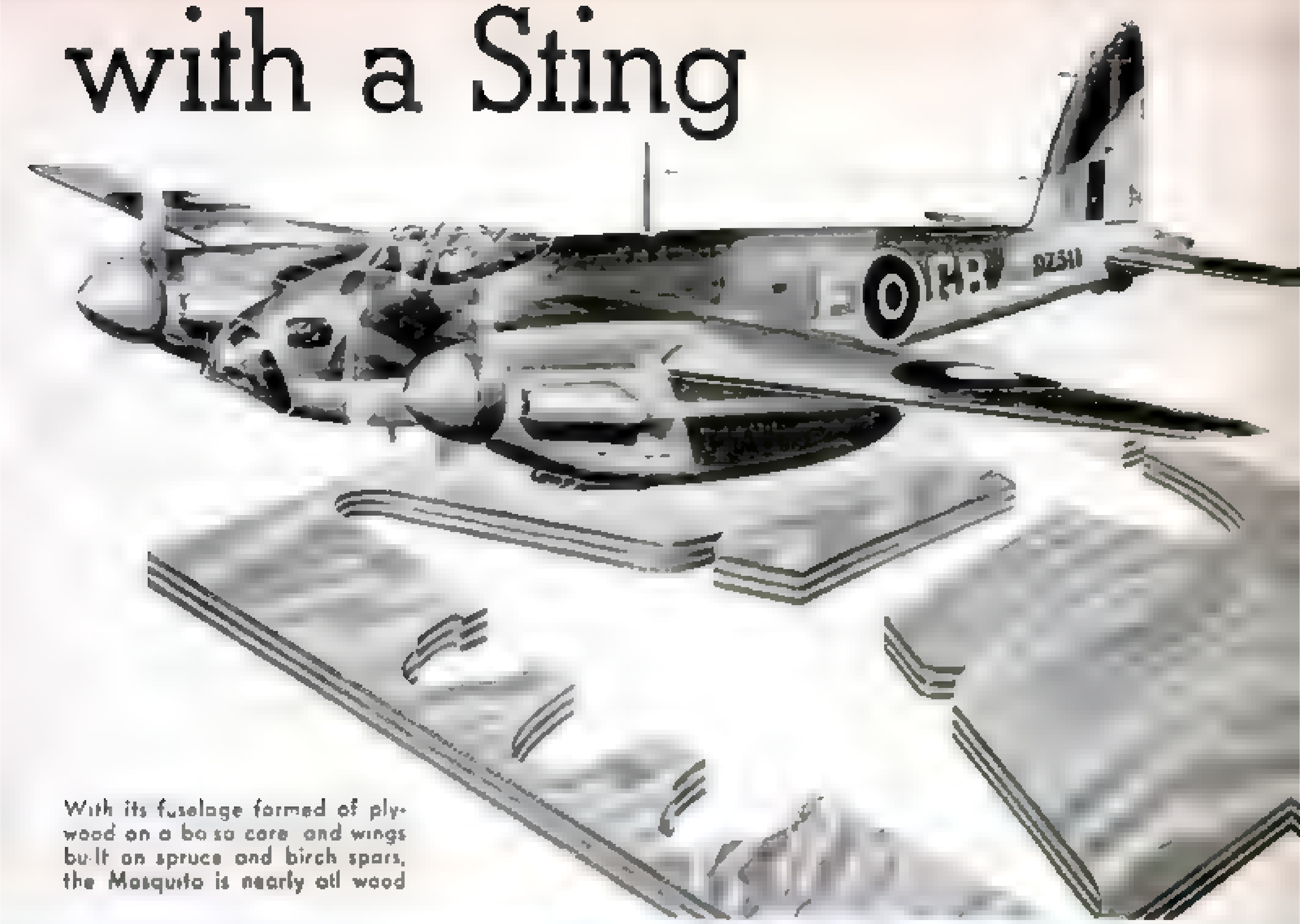
There is more to this new all-wood airplane than meets the casual glance. The offhand observation would be that Britain was trying to bolster production with a type of airplane that would spare critical materials, tap hitherto unused labor supplies, and enable parts of the Empire which had wood and craftsmen available, but no aircraft metals, to take part in the airplane-building program. In essence all of these facts are true, but they are only supporting reasons for building the Mosquito. The De Havilland 98, as the ship is officially designated, embodies the most advanced method of nonmetal airframe construction. Its wooden frame has proved to be equal to metal in strength-for-weight, superior in surface rigidity (important in high-speed operation), and much easier to repair and maintain than metal frames. Furthermore, this type of airframe is cheaper to build and modify, since it requires only woodworking tools, which cost less than tools for metal.

For over two decades, advocates of wooden airplane structures have pointed out that there is nothing wrong with wood as an airplane material. Any basic disadvantage ascribed to wood construction stemmed from the adhesives commonly used—casein and blood-albumen glues, which are subject to deterioration from moisture, fungus, and bacterial action. The advent of synthetic glues, particularly those in the urea-resin family, put an end to this objection. Moistureproof and decay-resistant, they lend themselves to a process known as bag-molding, by which plastic-plywood struc-

VITAL STATISTICS

ENGINES:	Two 1,350 hp.
WING SPAN:	54 feet 2 inches.
LENGTH:	41 feet 2 inches.
GROSS WEIGHT:	18,500 lb.
SPEED:	400 class.
CREW:	Two.

with a Sting



With its fuselage formed of plywood on a balsa core and wings built on spruce and birch spars, the Mosquito is nearly all wood

SKILLED WOODWORKERS GET A CHANCE TO BUILD PLANES

HOW THE JOINTS ARE MADE

Bag-molded around prebent bulkheads, half sections of the fuselage are finished and fitted with hydraulic and electric equipment before they are joined to form a complete fuselage. Special joints bind them neatly and firmly in an invisible seam as strong as any other part of the structure

Profile of flap section. The dark object at the tip is a counterweight. Left, fuselages ready for wings and engines

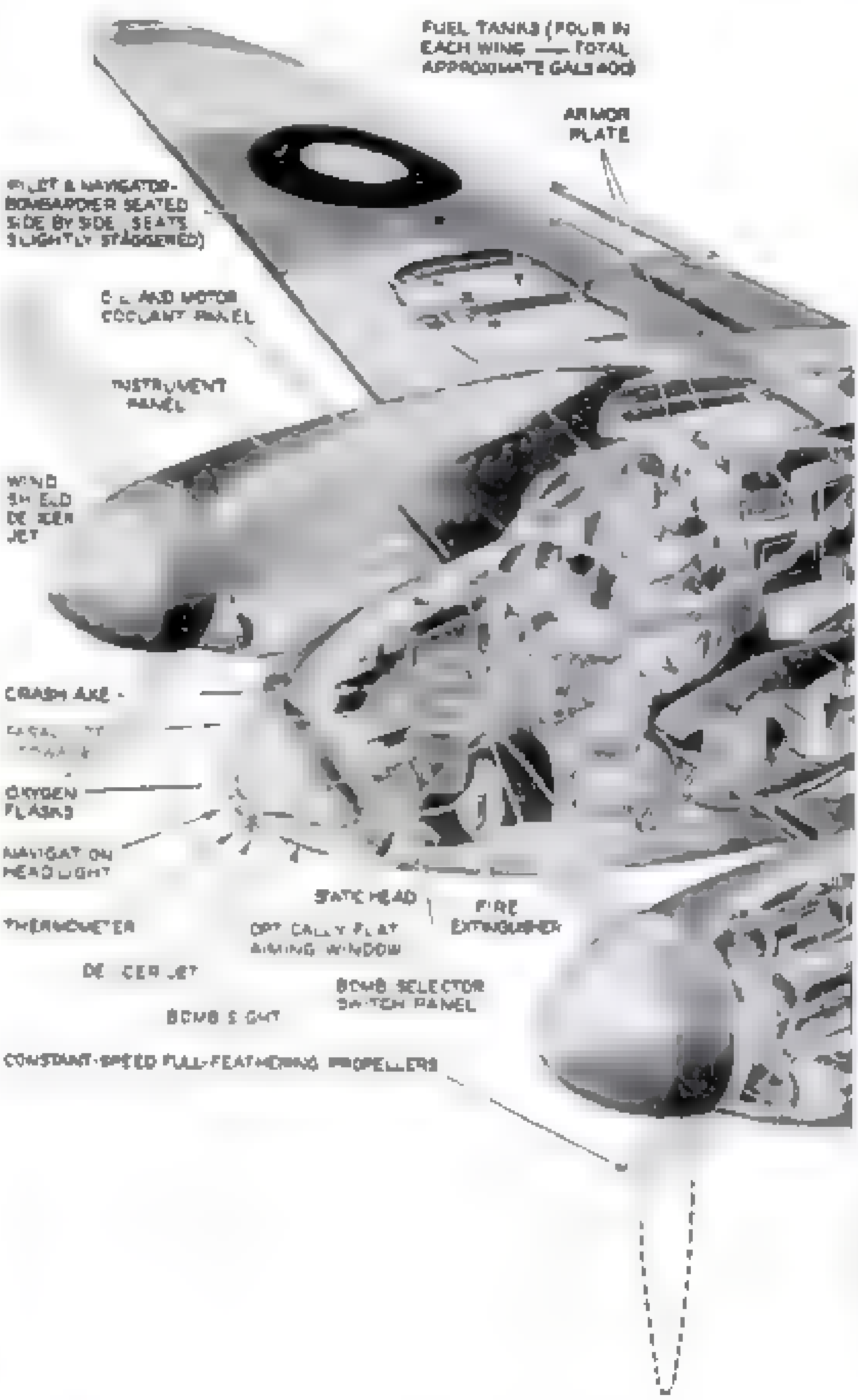
tures can be shaped into compound curves, formerly procurable only through the use of stamped and hammered light metals.

The Mosquito is a basic high-performance type, which can be modified to perform many tasks. Over a dozen variations, ranging from the full fighter version to the full bomber, are in use. Modifications vary the armament, bomb load, and engine setting to such a degree that no attacking pilot can be sure of what he is tackling until he is actually in combat with the Mosquito. If he thinks he has a bomber and winds up with a fighter on his hands, he can really be in for a tough time.

The first 22 months of war saw no combat plane bearing the long-respected name of De Havilland on the R.A.F.'s plane roster. After the results of the debacle in France had been tallied, the types of aircraft that England would need in the future were laid out. It was determined that the heavy-bomber and fighter program would absorb most of the Empire's metal allocated for aircraft. There would, however, be need for an "infielder"—a ship that could be modified to do a little of everything. This ship would have to be produced in quantity, and without upsetting the supply and labor schedule of the fighter and bomber program.

De Havilland provided the miracle. Wood was the great untapped material, and woodworkers were the major undrained labor pool. Furthermore, this applied to the entire Empire: Canada, India, Australia, and New Zealand all could turn out complete Mosquito airframes. The great Packard works, augmenting and even surpassing native British production, were capable of powering the Empire's Mosquito output.

Details of construction and equipment of the Mosquito are shown in this cut-away drawing. Armament varies according to the use to which the plane will be put, ranging from the full fighter with four machine guns in the nose and four 20-mm. cannon in a belly hatch to the full bomber with no guns

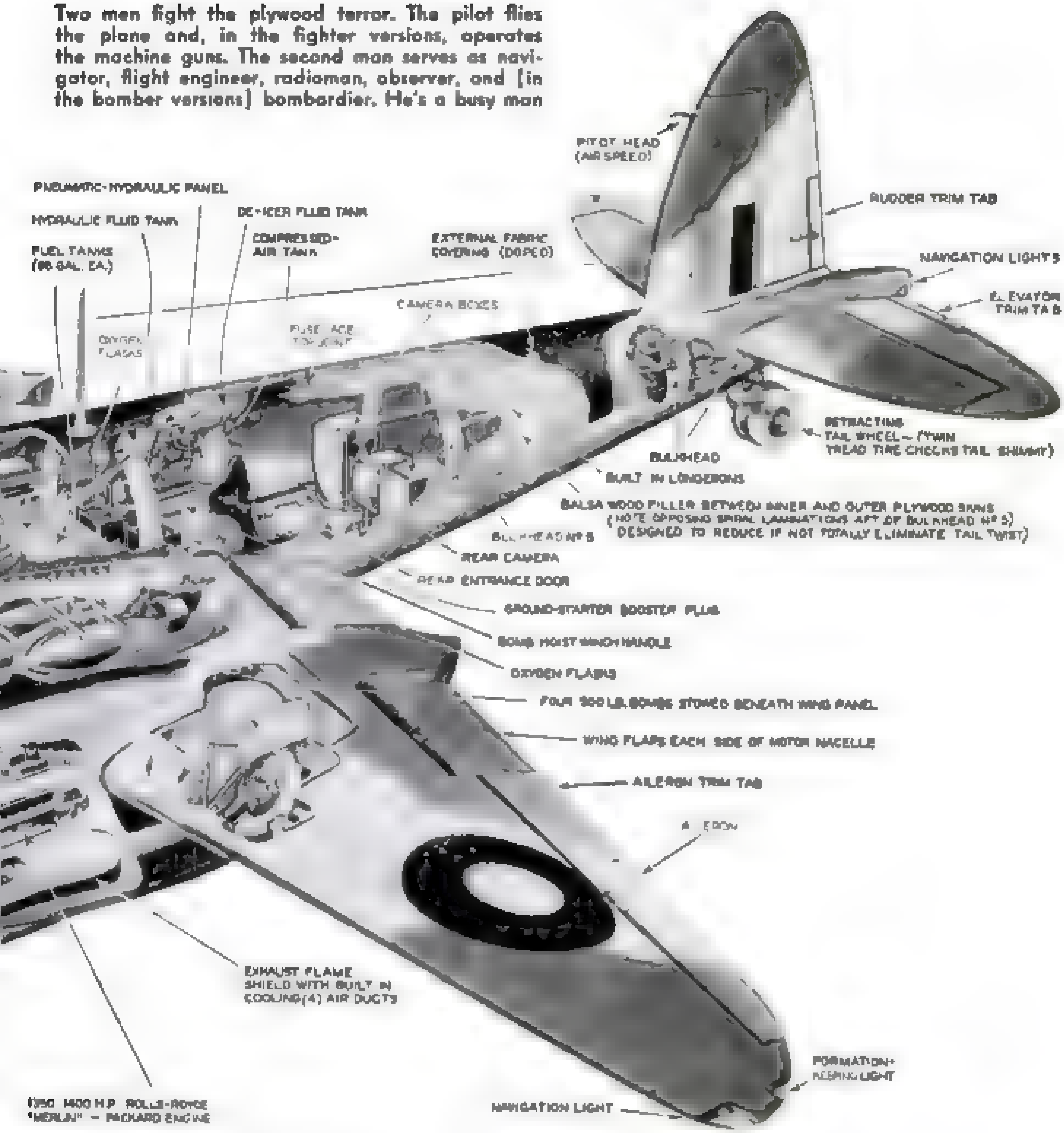


The featherweight fuselage is as close to the true monocoque or stressed-skin structure as has ever been attempted in a military airplane. The problem of building an airplane fuselage is to build not only a strong structure, but also a rigid one. In metal aircraft, this problem is solved by building a series of bulkheads, connecting them with stringers, and then covering the entire surface with a metal skin. Earlier all-wood airplanes, like the immortal Lockheed Vega (Wiley Post's "Winnie Mae" was one), followed a similar system, but used prebent wood members and a steam-molded plywood skin.

The Mosquito's fuselage is made of standard veneer, built up into plywood on either side of a balsa core. Since balsa has virtually no structural strength of its own, the wood veneer, usually spruce, birch, or mahogany, actually carries the stress. The balsa merely stabilizes the plies, spacing them apart—in effect turning the entire section into one continuous box spar.

The wing is a one-piece full-cantilever structure, built up of two box spars. These consist of spruce flanges on a birch connecting web. One of the factors that cut down top-bracket performance on metal-skinned airplanes is a phenomenon known as "tin-canning," the waving of metal between the

Two men fight the plywood terror. The pilot flies the plane and, in the fighter versions, operates the machine guns. The second man serves as navigator, flight engineer, radioman, observer, and [in the bomber versions] bombardier. He's a busy man

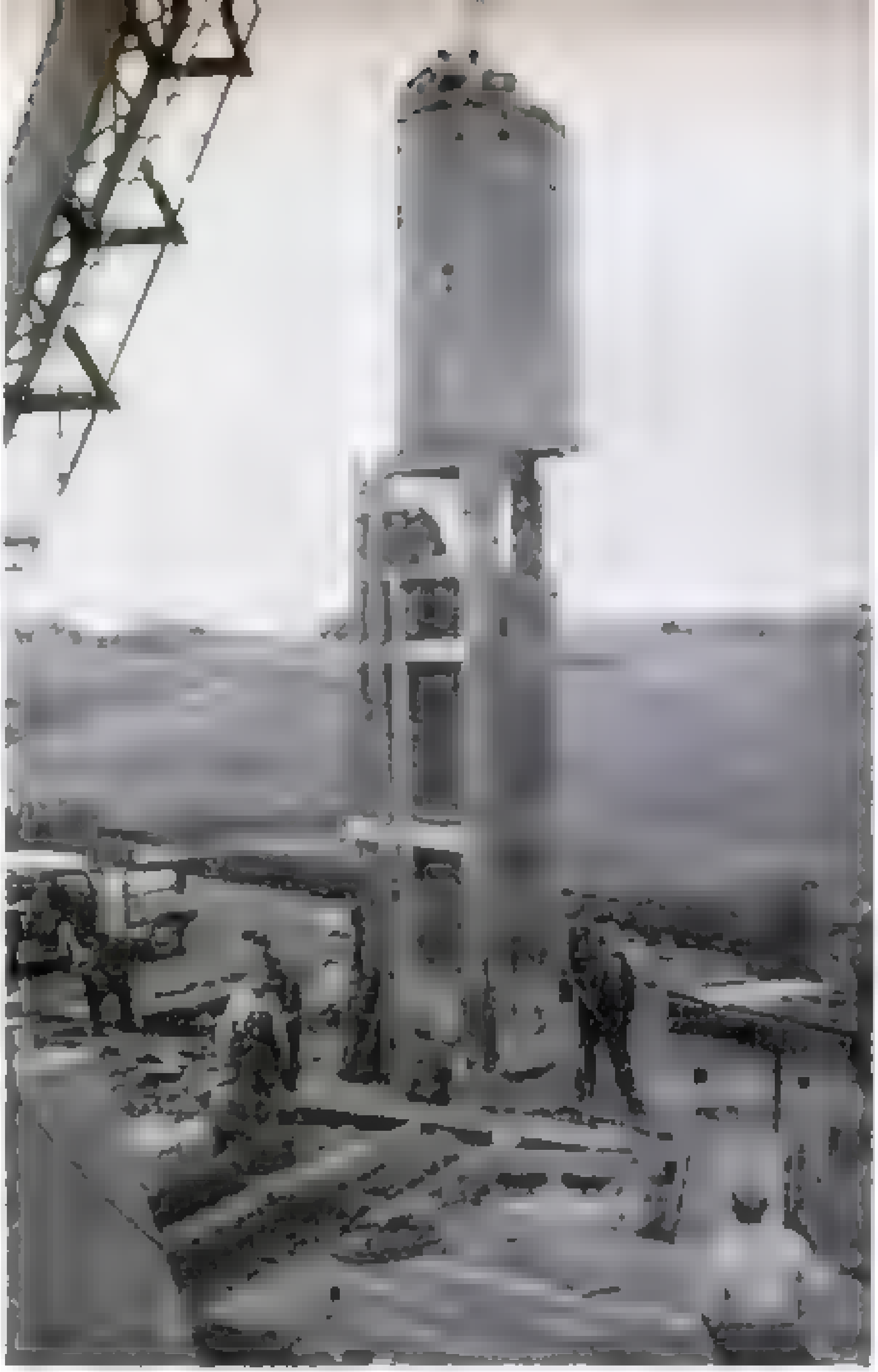


rivets, caused by the native elasticity of thin sheets of light aircraft metal. This particularly affects the highly curved upper surface of the wing, impairing lift and palpably increasing parasite resistance. Plywood, properly reinforced, does not "tin-can."

The lower surface of the wing is a simple sheet of plywood, glued and screwed to the ribs. These are also simple units—single plywood blanks, spruce-edged. The upper surface, however, is a double plywood skin, separated by hardwood spacers which turn the entire stress-bearing upper surface into a series of box spars for great strength and absolute stiffness. The ailerons are of conventional metal frame, sheet-alloy covered. The slotted flaps, or air brakes, are of plastic-plywood like the rest of the ship.

The Rolls-Royce XXI engines are mounted in welded-steel tube mounts, bolted to the front spar. Radiators are installed in the leading edge of the wing, between the engine and the fuselage. Self-sealing tanks are installed according to the military use of the plane.

The full fighter version, used as both night and attack fighter, has four .303 caliber machine guns in a flat arrangement in the ship's nose, *(Continued on page 222)*



Above, a 30-ton core of solid rock cut at the Zenith iron mine, at Ely, Minn. At the right, the rock corer, shown resting on a wooden stand, has been lifted out of the hole it has just drilled to allow the core puller to be sent down. Before it can be pulled, a core must be either wedged or dynamited loose from its base

He Bores Bigger Holes

HOW A CALIFORNIA ENGINEER SOLVED A PROBLEM AND REVOLUTIONIZED METHODS OF DEEP MINING

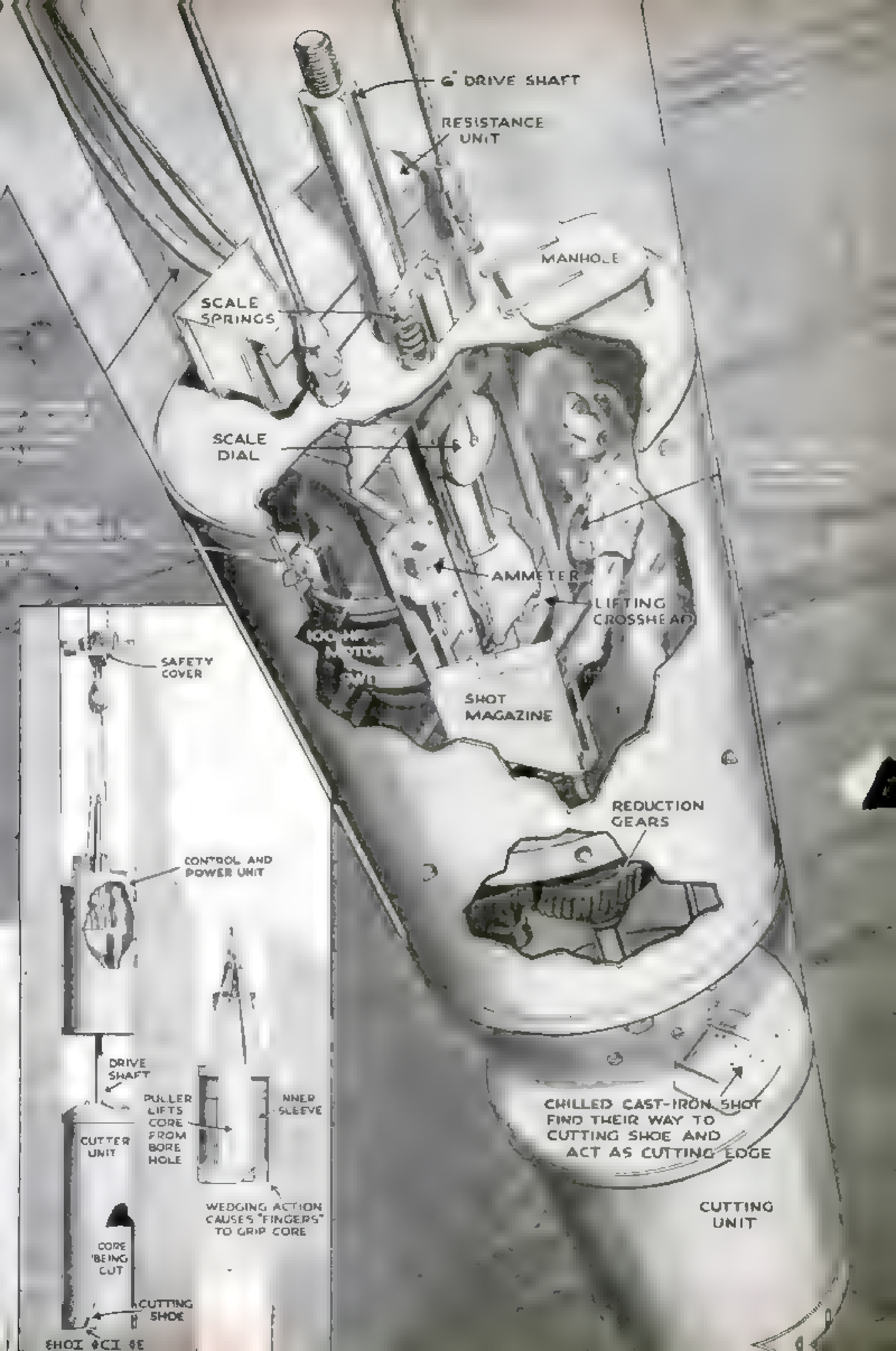
By ANDREW R. BOONE

Drawing by B. G. SEIELSTAD

AN EARTH-GNAWING machine that contains within its cylindrical metal hulls all the equipment necessary for eating its way through solid rock is reshaping the art of mining. Already the machine has chewed two deep holes opening new shafts into California and Minnesota mines, and today, 1,000 feet below the earth's surface at Hurley, Wis., it is cutting a mine shaft down toward the 3,000-foot level of an operating iron mine. So quietly has this coring device been developed that few outside the mining business know of its existence.

Most core drills, turned from the surface by long shafts, take samples measuring only a few inches in diameter and can probe only to limited depths. This rock eater, invented by Branner Newsom, a California mining engineer, knows no limits. Suspended by steel cables, it can push down as deep as mines can be operated. Anchored against the smooth wall of the hole it digs, the rock corer and a companion lifting device gulp up great columns of the hardest rock in chunks 16 feet long and 5½ feet thick.

For the first time in mining history, explosives are not needed to sink large shafts. An inexpensive wooden superstructure prevents the power end of the corer from



6" DRIVE SHAFT
RESISTANCE UNIT
MANHOLE
SCALE SPRINGS
SCALE DIAL
AMMETER
LIFTING CROSSHEAD
SHOT MAGAZINE
REDUCTION GEARS
CHILLED CAST-IRON SHOT FIND THEIR WAY TO CUTTING SHOE AND ACT AS CUTTING EDGE
CUTTING UNIT
SAFETY COVER
CONTROL AND POWER UNIT
DRIVE SHAFT
PULLER LIFTS CORE FROM BORE HOLE
INNER SLEEVE
CUTTER UNIT
WEDGING ACTION CAUSES "FINGERS" TO GRIP CORE
CORE BEING CUT
CUTTING SHOE

turning when the cutting tube first begins to grind its way into the surface. When the entire machine is buried up to its head, the operator screws six jacks into the earth to prevent the power cabin from turning. By means of a screw mechanism he adjusts the weight of the drill on the bottom, starts the 100-horsepower electric motor whirring, and continues drilling.

Operating this borer is very much like whirling a glass tumbler upside down in a bucket of lard. Pressing down firmly, you turn the tumbler until it has cut a core. Then, if the lard is chilled to resemble hard rock, you remove the tumbler, send down a tin can whose sides have been cut into strips which may be forced inward near the bottom of the lard core, and lift it out.

A motor that turns at 1,750 r.p.m. is geared down to turn the drill at 52 r.p.m. During the drilling, a single operator stands alongside the motor, where he pays close attention to the controls consisting of a starter button, an ammeter, a mechanism that regulates the weight of the cutting shoe against the bottom, and a box containing a quantity of chilled gray iron shot.

The cutting shoe, a 1½-inch-thick ring that is welded to the lower rim of the core barrel, is softer than the iron pellets, which measure 3/32 of an inch in diameter. By pulling a lever, the pellets are fed down the outside of the core barrel from which they work their way to the lower edge of the shoe; there they become embedded in the lower edge of the toothed cutter and take up their job of scraping and abrading the rock. Powered by a short shaft, the barrel turns with the teeth, eating away a circular slot two inches thick around the standing core.

When the core has been cut to the desired depth, and the water and cuttings have been bailed out, the operator descends to the bottom in a small bucketlike container. He drives a 75-pound bull wedge between the core and side wall, or lowers to the bottom of the slot a specially designed time bomb containing a small charge of dynamite. When wedged, the core tilts to one side, snaps loose at its base, and then settles back to vertical after the wedge is removed. Dynamite shears the standing column by suddenly forcing it sideways. The explosion, however, sometimes shatters the rock, and is the less preferred method of breaking the core loose.

Now the core puller is sent down. This ingenious device consists of outer and inner shells. Only the outer shell is attached to the hoisting hook, and when lifted it causes the gripping dogs of the inner shell to grasp the core. Pressure is released automatically when the core is rested on the ground.

If a mine owner should want to change the shape of the hole to square or rectangular, three men, one on each platform of a triple-platform lift, descend into the hole with air drills and bore to the desired depth rings of holes that slant upward. A huge bucket whose capacity equals the amount of rock to be blasted is lowered and sealed against the walls by an inflated rubber tube. An electric switch is closed, the shattered rock falls, and the bucket is hoisted to the top, where it is emptied. The process is repeated throughout the length of the shaft.

Newsom started developing his remarkable machine 10 years ago in the limestone district of southern Indiana, where he was engaged to quarry building stone. His company desired to quarry out a block 100 feet square, but overlying the limestone was 30 feet or so of roughtop which had to be blasted off before workers could get at the valuable rock below.

Newsom contracted to separate the roughtop from the stone by wire-sawing, a process he had studied in Europe several years earlier. To anchor the wires, though, it was first necessary that he drill at one corner a hole 50 feet deep and three feet in diameter. Unable to purchase or rent a drill, he quickly contrived a crude model from glue, cardboard, spools, and dowel pins, and found at near-by Indianapolis a machinist who could produce the finished job. So well did the apparatus work that it completed the hole without serious mishap, and shortly thereafter Newsom returned to California convinced that by making a few changes he could core holes of any size to any depth.

Those changes proved many and complex. His original Indiana machine was powered by an electric motor which was connected, by means of a cable and bull wheel, to a lengthening shaft extending from the surface to the drill. Bearings made from railroad ties and placed at 10-foot intervals kept the shaft from whipping in the hole. But long shafts, whipping like angry serpents, could not be expected to prove feasible in deep holes.

Soon he encountered a mining problem that inspired him with the answer he was seeking. Deep in the Idaho-Maryland mine in Grass Valley, Calif., gold ore was being broken down and hauled a mile, then lifted up a 1,100-foot shaft. To Errol MacBoyle, president of the company, Newsom offered what seemed like a wild idea. "Why not," he asked, "sink a new shaft right down to where the mining's going on? We can bore, and no blasting required. You'll save two miles a day for each shift and a mile hauling every load out."

Intrigued by the idea, MacBoyle authorized

Newsom to proceed with the plan. Newsom considered many ideas for the kind of machine he needed, finally discarding all save one: a power plant connected by a short shaft to the drill, and both to be completely buried in the earth. Soon he assembled the machine, and, in the face of doubting miners, locked himself in the operator's compartment and started the 40-hp. motor whirring.

For 21 months Newsom labored on that hole, driving through abrasive gabbro, swelling gouge, blocky serpentine, and firm serpentine. Sometimes he cored only a foot or two during three shifts. Once the bit bored 16 feet in a day's run. But at last he landed 1,125 feet down, demonstrating to miners everywhere that he actually could do what he had promised to do—"eat" his way into a gold mine.

It wasn't long before another mining company, Pickands, Mather & Co., wanted to know if he would core a dual-purpose ventilating and hoisting shaft 1,206 feet down to the fourteenth level of their Zenith iron mine on the Vermillion Iron Range at Ely, Minn. This one, however, had to be slightly larger than the California hole, about 5¼ feet across. Again redesigning his machine to handle the larger job, Newsom started boring. And again, as in Grass Valley, the drill chewed through all kinds of rocky formations, including the toughest to be found anywhere—greenstone and chert. The drill slowed down on this, sometimes descending only six inches an hour. But it made the old-timers around Ely rub their eyes as the graveyard of 20 and 30-ton greenstone cores grew day by day. In a few days less than seven months, Newsom's machine had cut its way down to the 1,206-foot level.

Branner Newsom, California mining engineer and inventor of the rock-coring machine, exhibits a model of the device which is used to haul the rock cores to the surface. Consisting primarily of an outer and inner shell, the core puller, suspended on a cable, is dropped into the hole and lowered over the core. Tension on the cable causes the inner shell to grip the core firmly. After it has been lifted to the surface, the core can be quickly released from the puller merely by resting it on the ground and thus relieving the tension on the cable.

This success brought other interested miners to Newsom's door. Would he risk his hard-won reputation on a 3,000-footer? The answer is in the making at the Cary iron mine, on the outskirts of Hurley, Wis. Already the machine has driven a 5½-foot hole a little over 1,000 feet toward its destination. If and when it lands, powder men will blast down the walls to form a 19 by 26-foot shaft. Thereafter the mine hoist will lower miners close to the ore body instead of landing them some distance away. Boring will save both time and ore, for in the blasting method, which shatters nearby rock, a tremendous shaft pillar, resembling a huge subterranean pyramid, must be left to provide strength around the shaft.

Now that he has tested the submerged drill in three successful ventures, Newsom contemplates adding more power, building heavier and larger equipment, and aiming at deeper objectives. He's convinced he can build a machine to take cores 20 feet thick.

He would like, too, to try sinking two shafts simultaneously, one to carry fresh air down, the other to bring foul air out. A single derrick could swing the machine from one hole to the other while clean-up and core-lifting proceeded.

WESTERN ESKIMO

I am hungry . . . . . . **Kish-tu-ah** (the i long, as in mice)

Our food is all gone . **Neck-out-voot nakng-ock**

Water . . . . Meck (fresh); Mahk (salt)

EASTERN ESKIMO

I am hungry . . . . . . Kah-**paung-ah**

Our food is all gone . **Ner-key-voot peeto-hung-i-tu-goot**

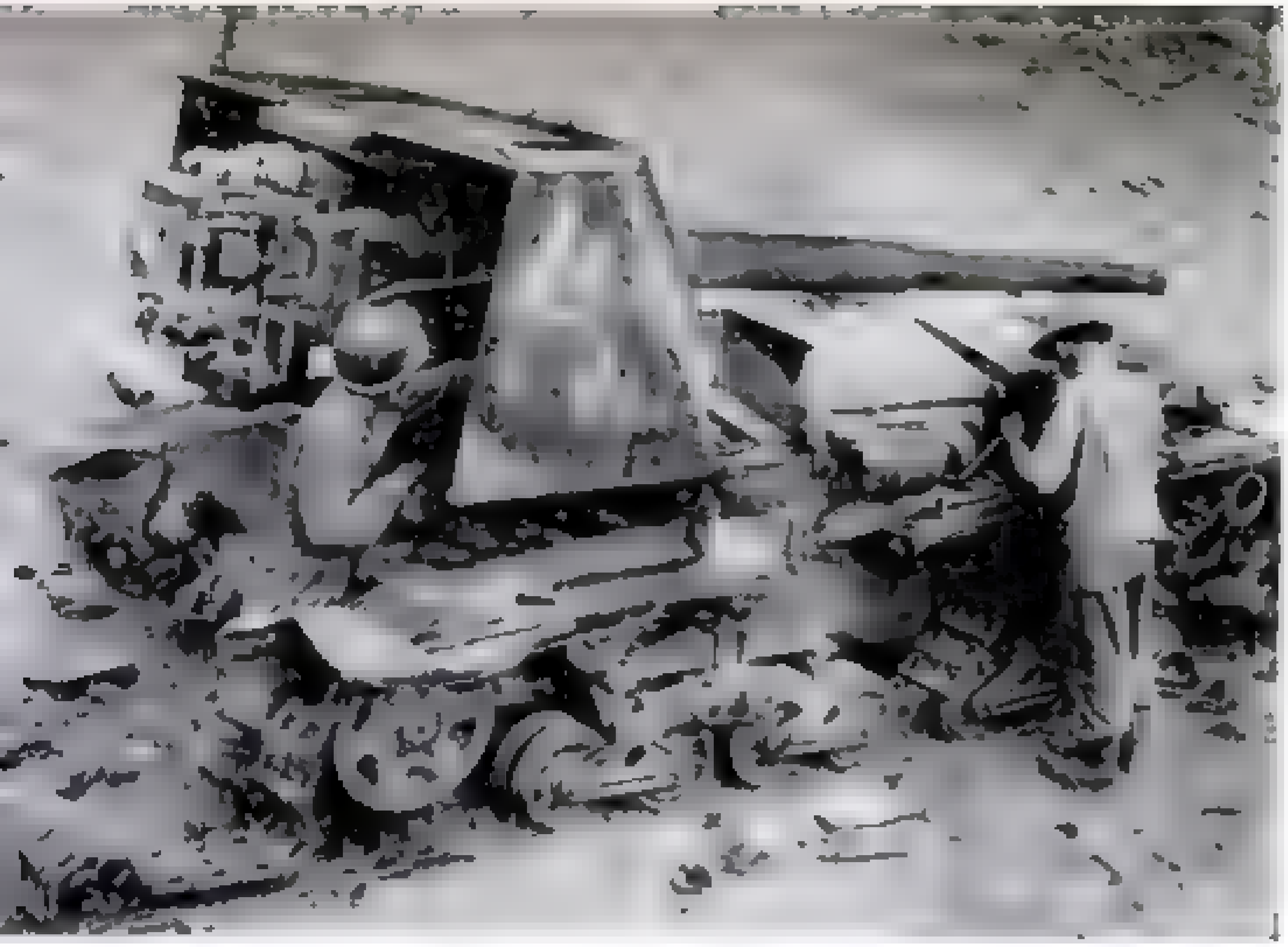
Water . . . . **Ee**-mick (fresh); **Ee**-mock (salt)

Protect your face with a loose cloth fastened to your parka

Double socks filled with cushion stuffing will protect your feet

TALKING TO ESKIMOS is just one of the many details of life in the Arctic covered by a new booklet published by the U. S. Army Air Forces for the guidance of flyers who may be forced down in the far north. "You can beat the Arctic," is the reassuring message in the foreword of "Arctic Emergencies"; it tells how by giving practical advice on landings, clothing, shelter, heat, food, water, and signals to rescuing planes. Besides dispelling some imaginary terrors of the north, such as the fear of freezing while asleep, it gives instructions for avoiding the real dangers and hardships of frostbite, snowblindness, carbon-monoxide poisoning, and insect pests. Hungry airmen will be grateful for the section picturing edible plants, fowl, and animals. Tips on using plane parts for skis, and tires for rafts, enable flyers still to "travel by plane."

FLOTATION BAGS carried by land planes in flights over water are now ejected and inflated in less than a minute to keep the craft afloat after crash landings. A water-sensitive device developed by Walter Kidde and Company operates the valves of carbon-dioxide cylinders which open hatches, throw out the bags, and inflate them the instant a plane touches the water. O. W. I. photo at left shows bags for a big bomber.



AN ITALIAN GUN knocked out during the Allied conquest of Sicily is shown above, being examined by two American soldiers. This self-propelled, 96-millimeter gun was worsted in an artillery duel. Captured Italian weapons proved to be inferior in make and performance. This one, along with many more, will contribute to the Axis junk heap that grows wherever the Allies take over.

ANTI-INVASION GUNS mounted in Britain would riddle any enemy motor or torpedo boats supporting an attempted landing. These six-pounder coastal-defense guns, just off the secret list, have twin guns mounted in turrets with a 360-degree traverse. Below, British workers align the horizontal sights.

The exterior of the turret of a British twin six-pounder gun is seen below. This coastal-defense weapon first battered the enemy at Malta, when Italian troops carried by torpedo boats and E-boats attacked Valletta Harbor in 1941

TORPEDO TUBES mounted in waterside fortifications have been tried out by the Germans as an addition to their defenses on the coasts of Europe. Nazi military experts claim that the torpedo is a more effective weapon when fired from the land than when released by a plane or ship.

Plane News

BULLETPROOF GLASS manufactured in England guards crews of American bombers on their daring raids over Germany. At the right, members of the crew of a Flying Fortress are being shown a specimen of the steel-stopping window material by workers at the British factory where it is made. Later, the glass workers repaid the flyers' visit by going to an airfield of the U. S. Army Air Forces and seeing their handiwork installed on the big Boeing bombers which are hammering at the Nazi war machine in Germany and the occupied countries.

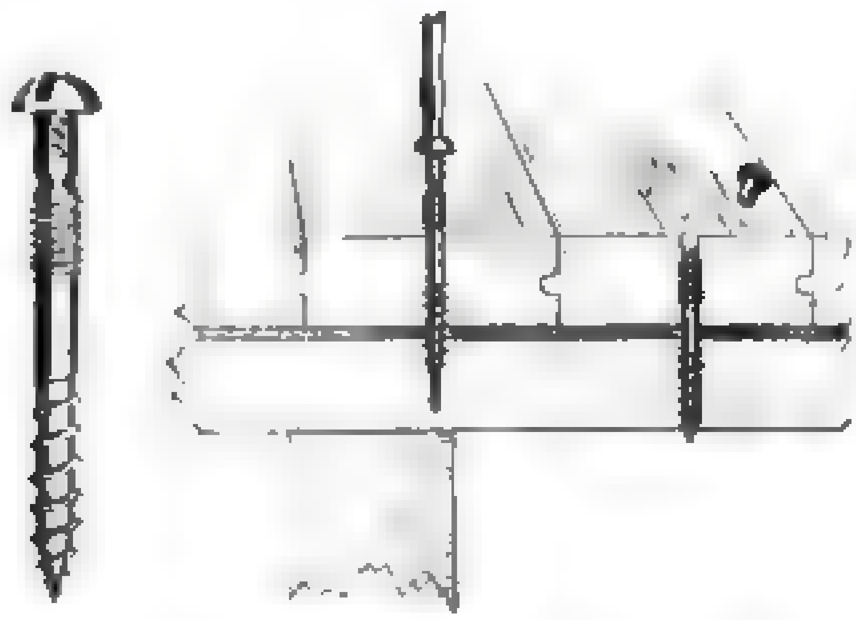
NEW MUSTANG. Powered by the new Packard-built Rolls-Royce Merlin engine, the latest version of the North American Mustang fighter reaches new heights as escort for the high-altitude heavy bombers of the U.S.A.A.F. A two-speed, two-stage supercharger furnishes the air compression needed by the engine in the rarefied atmosphere more than five miles up. The 1,520-hp. engine drives a constant-speed, four-blade propeller. The ability to fight "upstairs" in the realm of the German Focke-Wulf 190 is a startling departure for the P-51, which won its fame by its amazing performance as a fighter and fighter-bomber at medium and so-called "zero" altitudes.

A NOSE TURRET, electrically operated and mounting two synchronized-firing .50 caliber machine guns, adds to the already formidable fire power of the Consolidated Vultee B-24 heavy bomber. With other turrets in the tail, belly, and atop the fuselage, plus waist guns, the new armament gives the Liberator flexible fire power to meet attack from any direction. The photograph above shows how the new turret looks.

HAVOC'S GUNS. The young woman in the photograph at the right, so becomingly draped in a scarf formed by a belt of machine-gun cartridges, is one of the girls who check the armament of A-20 attack planes at a Douglas plant in California. Behind her is the nose of a Havoc with its four .50 calibers ready for a burst at the Luftwaffe.

FANGS FOR THE FORTRESS. Nazi fighter pilots who try swooping in head-on at our B-17's will get a warm reception from the two .50 caliber machine guns carried in new frontal positions on the big Boeing bombers. Recent tactics of the Luftwaffe dictated the placing of the guns, which, with 11 more in other positions, give the Fortress its sting.

ONE-MAN RAILROAD Over this homemade, 527-foot logging railroad Elbert M. Smith, 78-year-old farmer of East Lempster, N. H., hauls logs from his 40-acre timber tract across a swamp to his back yard. Rails are two-by-five pieces of fir mounted on piling and cribbing; the car is homemade with ball-bearing steel wheels bought at a machine shop the motive power is supplied by an old winch (at right), which was salvaged from a dump



SLIP-PROOF SCREWS marketed by the Wilson Mfg. Corp., of Chicago, employ two threads of different pitches to give permanent tightness and rigidity to joints. When a screw has been driven, the end is broken off and the hole sealed

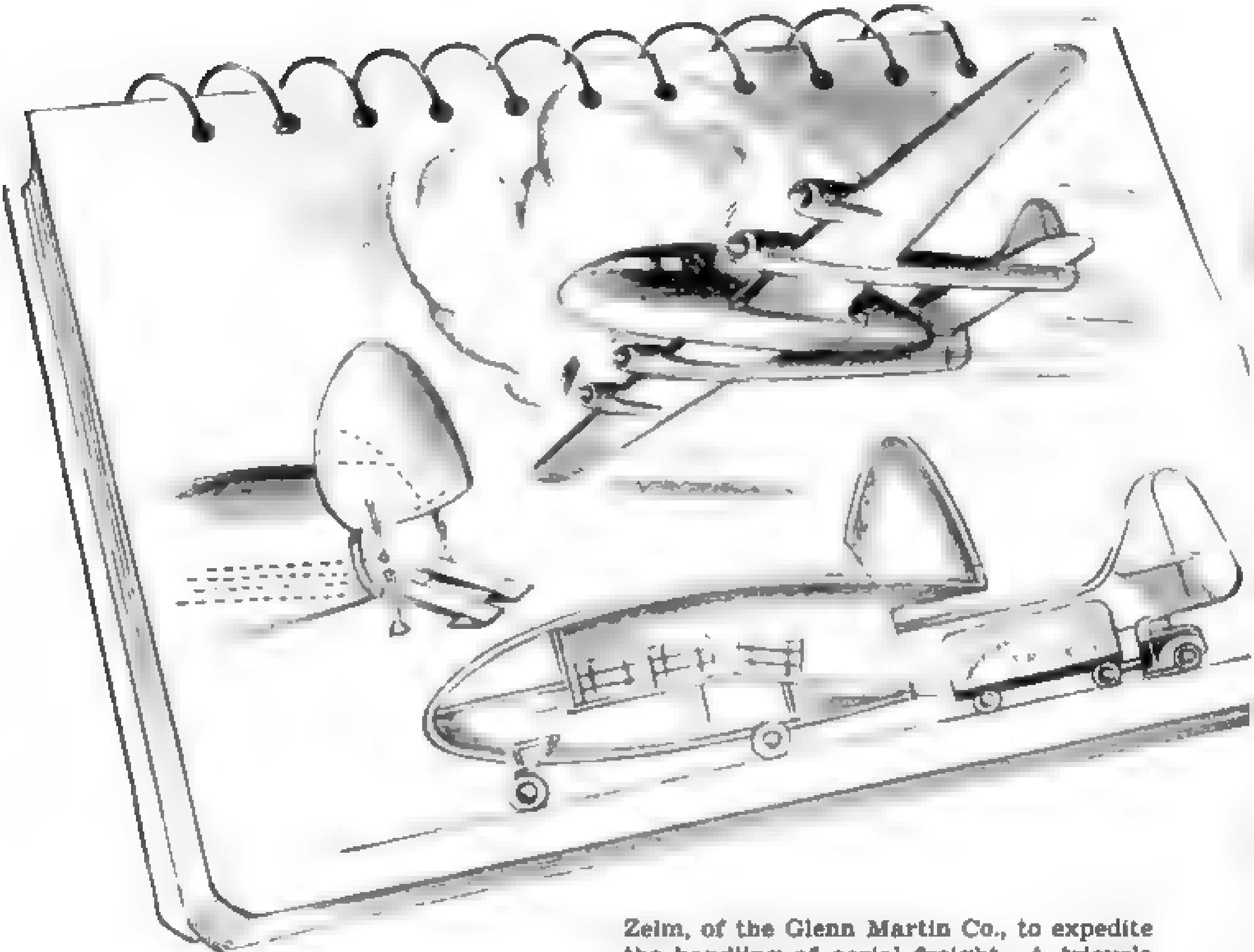
BETTER REFLECTORS for Navy searchlights are being produced by the Superfinishing process developed by the Chrysler Corporation for polishing automotive bearings (P.S.M., Jan. '41, p. 127). At left, a reflector is being tested

COUNTING JEWELS of pinhead size is no tedious chore with the ingenious device illustrated below. Used at the General Electric plant at Lynn, Mass., in the preparation of jewel bearings for aircraft instruments, it consists of a small tray containing 1,000 tiny holes. Jewels are dumped in the tray, and a gentle rocking causes one to fall into each of the holes. When all holes are filled, a slide is pulled and the 1,000 jewels fall into a bottom tray. A gallon jug would hold 550,000 of these jewels. A pound of them would cost $25,000.

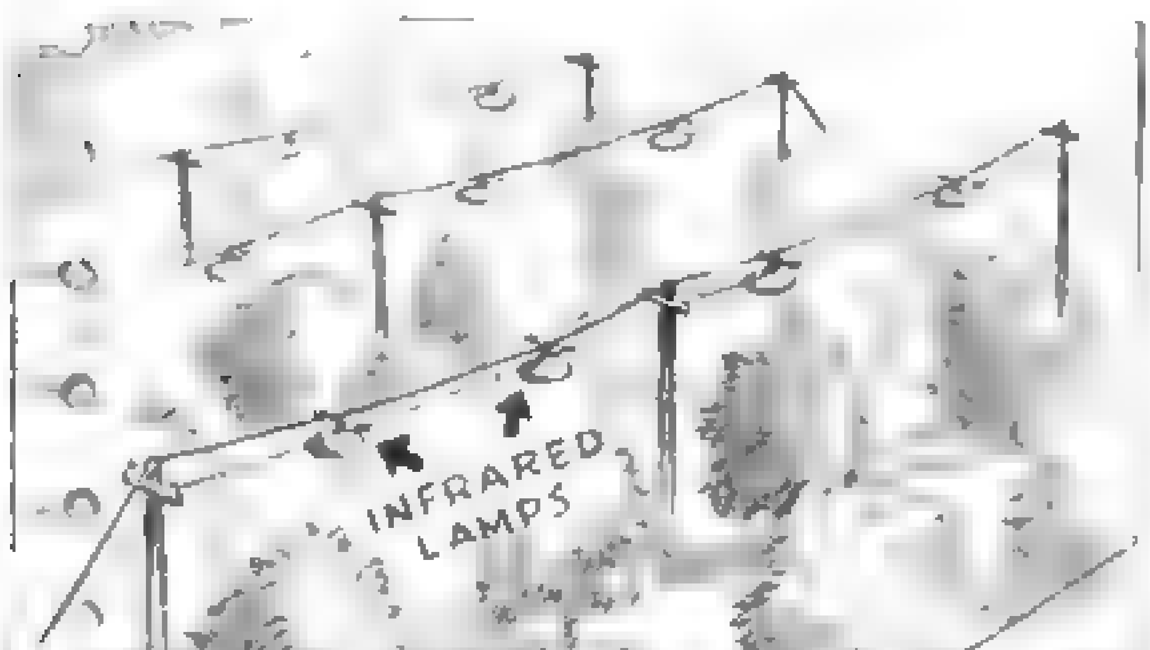
WORLD'S LARGEST four-bladed propeller is this hollow-steel-blade, Curtiss-Wright job designed for giant multimotored planes. Sixteen feet eight inches in diameter and weighing near 800 pounds, it embodies electric controllable pitch, constant-speed operation, and full feathering.

DIESEL ENGINES now furnish the motive power for our famous M-4 medium tanks and M-10 tank destroyers (self-propelled mounts for three-inch high-velocity guns). In the photograph at the left, Army mechanics are placing a General Motors Diesel in a land battleship. Diesels bring to the battlefield the same advantages that recommend them in peacetime industrial uses.

NEW IDEAS FROM



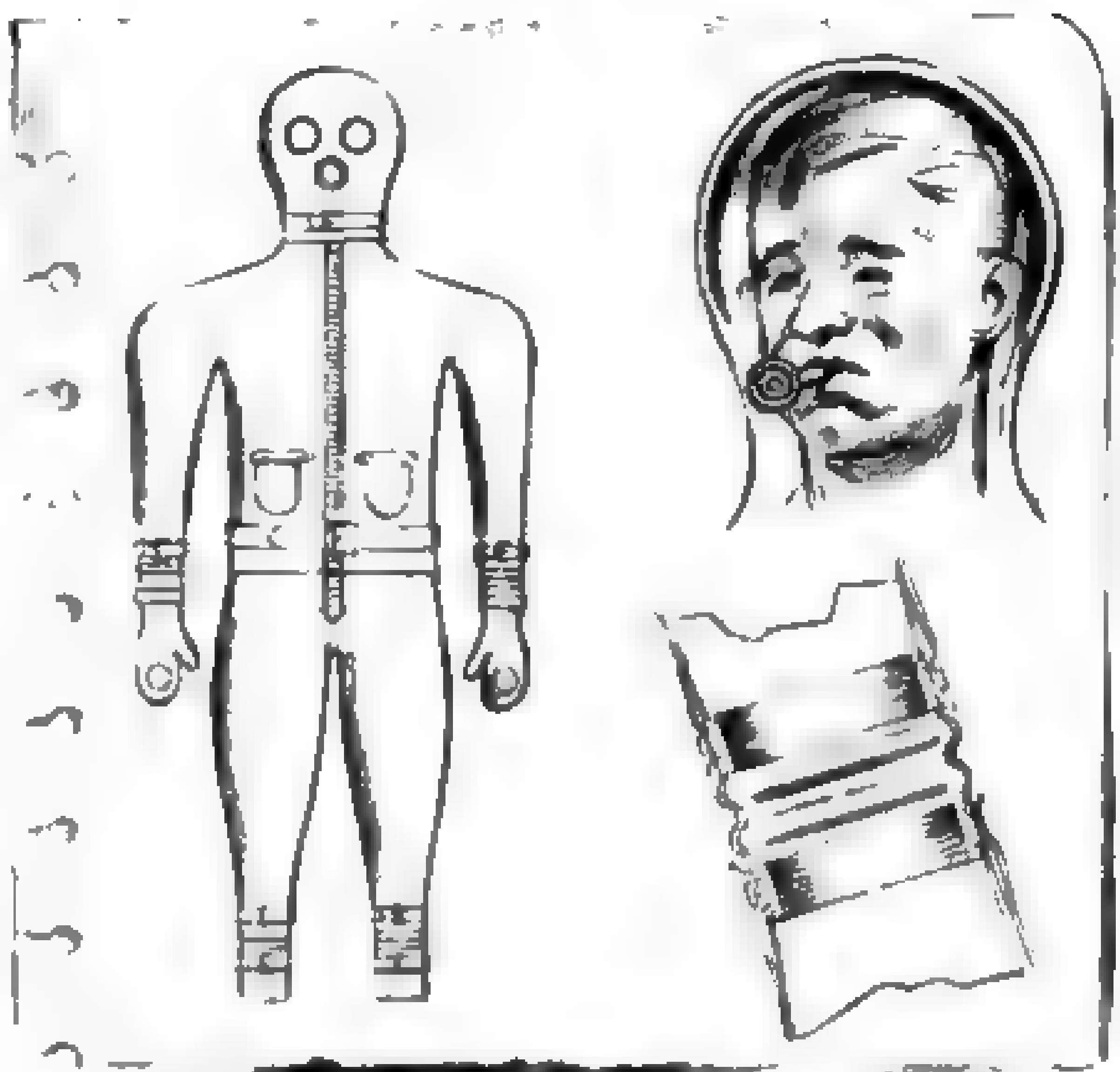
A POSTWAR CARGO PLANE, equipped with winches, ramps, and a hinged fuselage tailpiece that opens and shuts like a door has been designed by William van Zelm, of the Glenn Martin Co., to expedite the handling of aerial freight. A tricycle landing gear holds the plane level while, through the hydraulically raised door, the winches pull the freight up the ramps and into the fuselage. Supported by jacks, the ramps can run to the ground or to a truck.



INFRARED RAYS are suggested by Quinter E. Bashore, of Covina, Calif., as a means of protecting plants, especially those of the citrus group, from frost. Instead of smudge pots—expensive to operate because they must heat a large volume of surrounding air—Bashore advocates infrared lamps, whose rays can be thrown directly on the plants themselves. It is his belief that this protection will make possible the growing of citrus crops in more northerly climates.

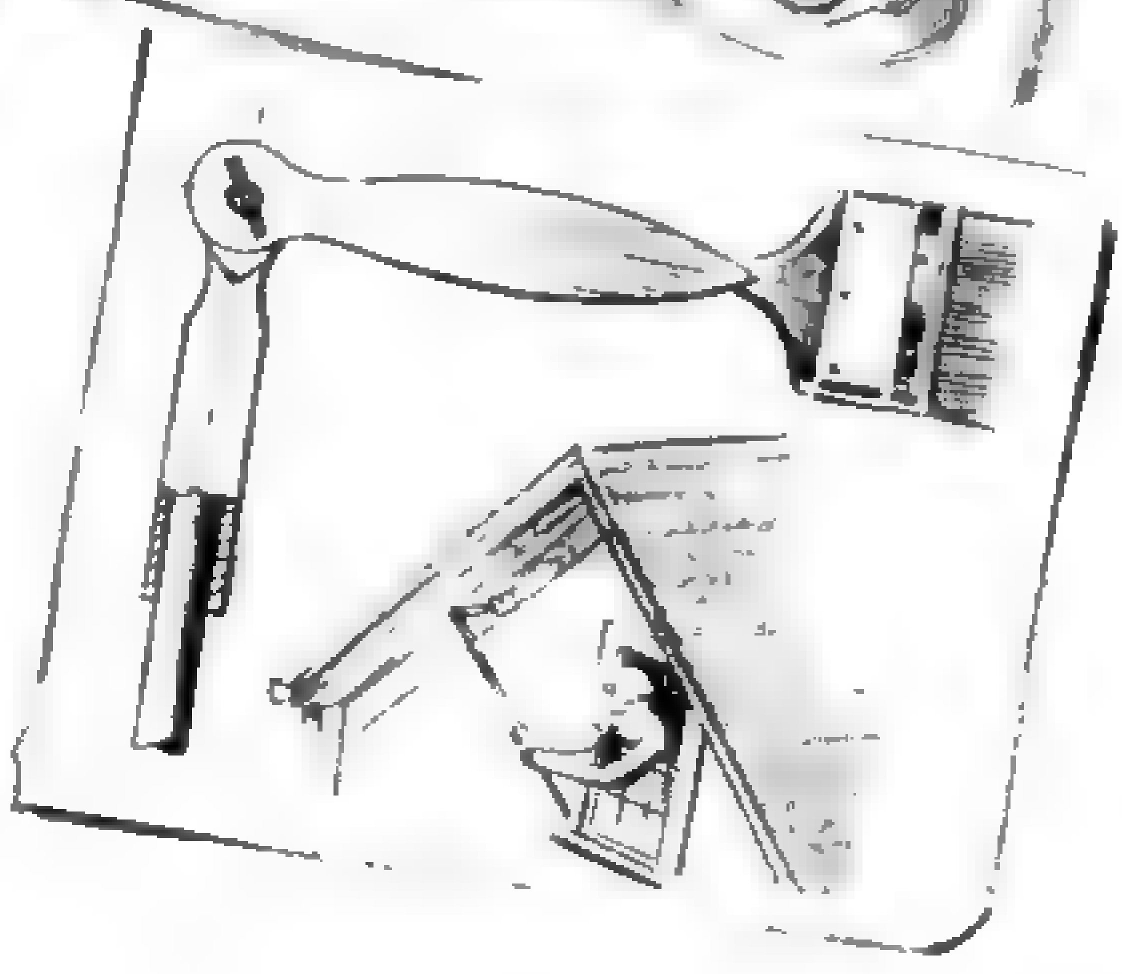
THE INVENTORS

A LIFE PRESERVER developed by John Norred, of Chicago, Ill., covers the wearer's entire body and makes it possible for him, by means of the valve through which he breathes in fresh air, to exhale into the interior of the suit and thus increase both his warmth and buoyancy. Made up of sections that can be quickly put on and are held together by reinforcing waterproof connections, the suit is also fitted with outlet valves in the mittens and hips. These are connected by rubber tubes to the lower sections of the trouser legs and can be operated independently to permit the escape of cold air and admit warm air from the torso of the suit.



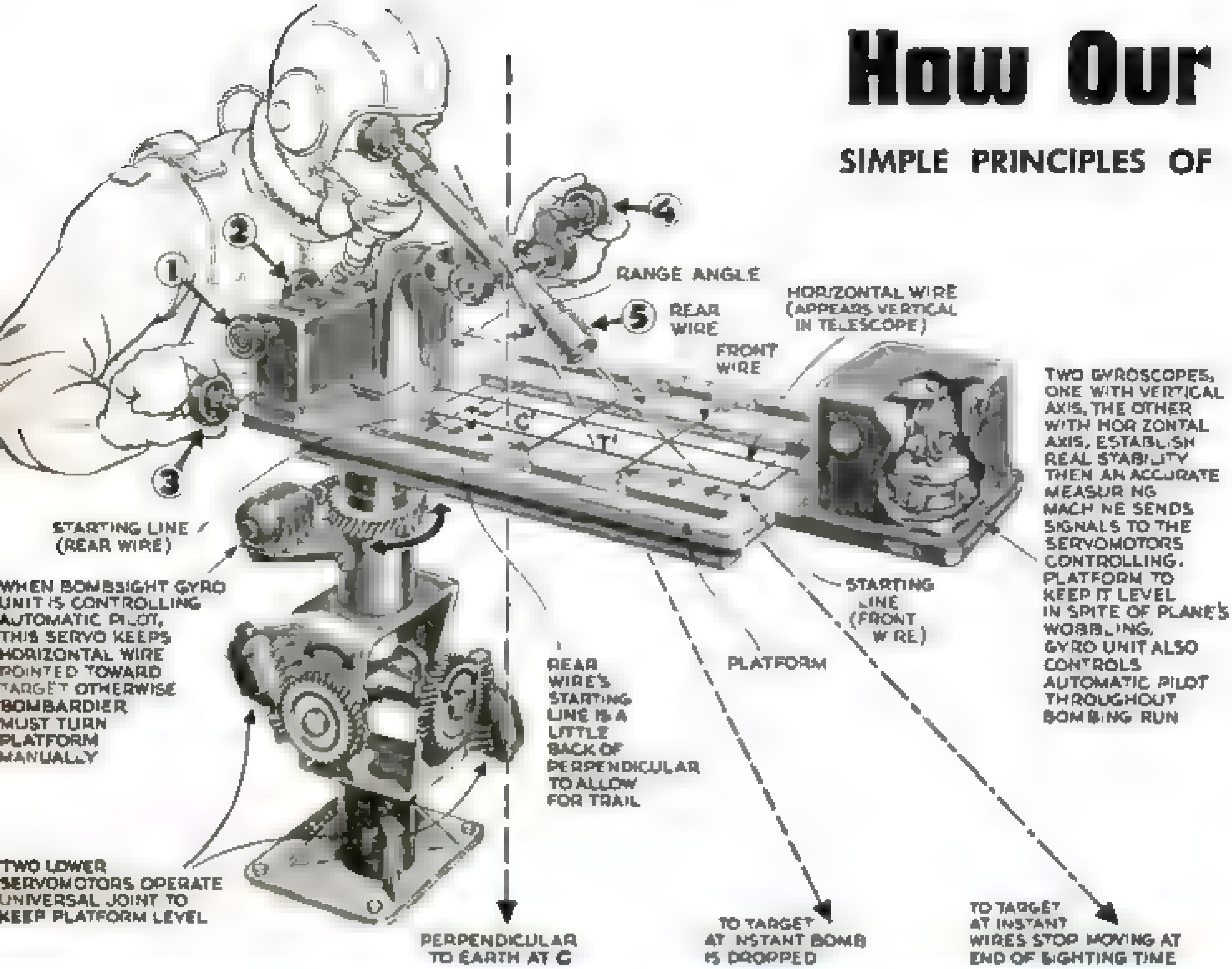
PACKING LOBSTERS so that they will stay alive for weeks can now be done with a cardboard or cellophane container which, after being partly filled with water, is given a needle injection of oxygen through a soft-rubber one-way valve. Enough oxygen is put into the container to raise the pressure from three to 40 pounds. The idea comes from Joseph Macdonald, Winchester, Mass.

PAINTING upper outside sections of a house from the safety of an attic or upstairs window can be accomplished with this wooden paintbrush holder designed by Gilbert T. Waldron, of Peekskill, N. Y. The brush is frictionally held in a groove in the top section of the holder, which, being connected to the holder handle with a wing nut, can be adjusted to any angle. The handle consists of two three-foot lengths, one telescoping into the other.

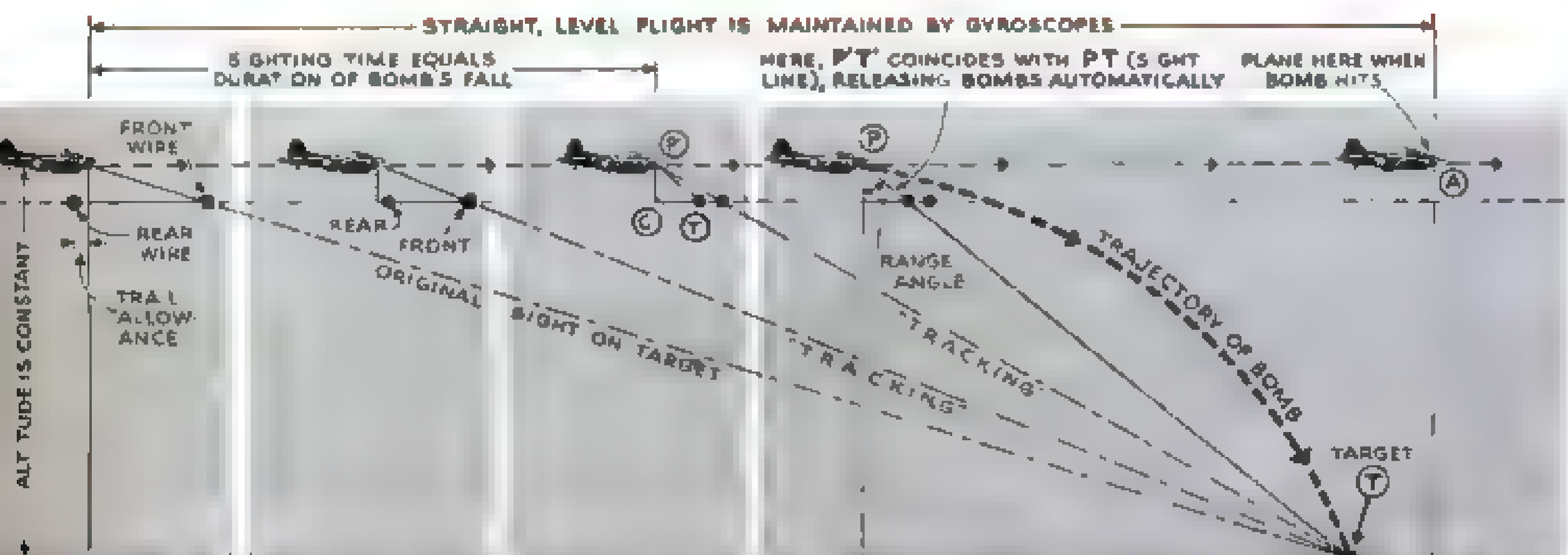


How Our

SIMPLE PRINCIPLES OF



Our artist's conception of a t ming type precision bombsight, based on best available information, illustrates the general principles on which such instruments work. Knob 1 on the calculator box is preset for the time it will take the bomb to fall, based on the altitude of the plane; knob 2 is preset for the bomb's trail, or lag behind the plane. This fixes starting position of the rear wire. While tracking the target bombard er manipulates knob 3, which moves front wire backward to keep it on target, and knob 4, which keeps target and front wire centered in telescope field (5). Rear wire moves forward as front wire moves back. Wires stop at end of sighting time. When telescope centers on rear wire, the bomb is released



...f start of sighting time, the rear sighting wire is ...ack of vertical ...ns; front wire ... on the target

With tracking, front and rear wires move toward each other as the plane approaches target

At end of sighting time, wires stop. A triangle (P'C'T') is set up in bombsight to time release

ACTUAL BOMBING

The telescope continues to track the target until its sight line coincides with P'T'. Now the ideal triangle in the sight is similar to that formed by vertical line, sight line, and range. Bombs away!

Bombsight Solves Problems

GEOMETRY AND BALLISTICS GIVE IT ITS DEADLY ACCURACY

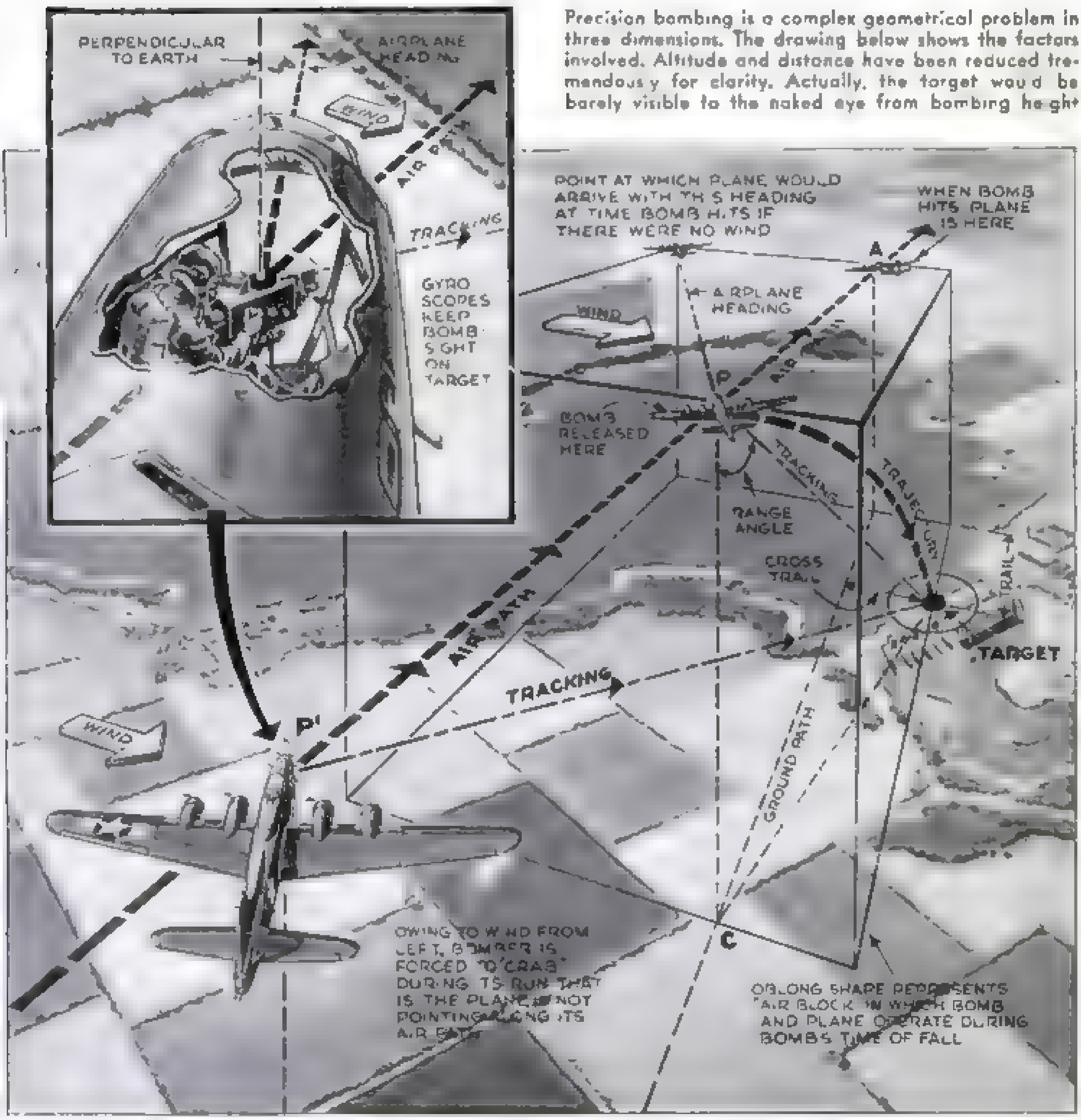
By ALLEN RAYMOND

Drawings by STEWART ROUSE

HOW does it happen that an American bombardier, crouching in the Plexiglas nose of a Flying Fortress or Liberator traveling above 200 miles an hour four or five miles above the earth, can drop a bomb with unerring precision on an enemy power house or moving train? The answer lies in precision bombing—a miracle of this war.

It is a miracle of mechanics and of human ingenuity, involving long research and experiment in such fields as higher mathematics, ballistics, electrical engineering, aeronautics, and optics. But the problem of how to bomb ground objectives precisely from high altitudes has been solved by American engineers to an extent not approached in any other country. It has been solved by the constant improvement of

Precision bombing is a complex geometrical problem in three dimensions. The drawing below shows the factors involved. Altitude and distance have been reduced tremendously for clarity. Actually, the target would be barely visible to the naked eye from bombing height



Jap sailors (in circles) duck as a stick of bombs from a Consolidated Liberator bomber falls near the bow of a 1,500-ton transport. The photograph was taken from another B-24, which sent the enemy ship to the bottom with a well-directed salvo

bombsights throughout the last decade; by the creation of automatic pilots and fire-control devices; and by the training of men to use these machines.

Three basic problems had to be solved before precision bombing became a practical method of warfare. One was the compilation and application of all the data needed to plot a falling bomb's trajectory. One was the stabilization of the line of sight, or the bombardier's aim, from a speeding, unstable platform. The third was the development of an automatic fire-control, or release, mechanism to take the inevitable margin of human error, as far as possible, out of the bombardier's operations and guide the bomb exactly to the target.

Consider the factors involved in these problems. The first and most obvious is that the bomb's trajectory has to be plotted from a sky platform traveling too fast for human computations of firing data, subject to movements upward, downward, and sideways, as well as forward; rolling and pitching like a ship at sea about three axes, two of them horizontal and one vertical.

What forces bear on the bomb's trajectory from such a platform? Three major ones have to be calculated accurately, before a bombardier can have any idea where his missile is going. One is inertia. One is gravity. The third is wind resistance. All three are working simultaneously upon that missile, causing the bomb to fall toward its mark in a steepening arc.

Inertia may be considered the first of these forces, since no explosive drives a bomb as a shell would be fired from a cannon. It is simply dropped from a rack. When dropped it is traveling forward just as rapidly as the plane which it leaves. Only gradually, as the bomb travels toward its objective, is this forward speed cut down, so that when it reaches the earth it is not far behind the airplane from which it fell.

Gravity is carrying it downward. Air resistance is acting upon it, lessening both its horizontal velocity and the downward acceleration due to gravity. Wind resistance is also bearing upon it, but this is simply a directional heightening of air resistance.

With these three basic forces at work on his missile, a bombardier, or his automatic bombsight, or both, must calculate the amount of time it will take a bomb to fall to earth, from its point and altitude of release to its target.

How fast does a bomb travel? A free-falling bomb, from a stationary platform, will fall, theoretically, 16.1 feet per square of the number of seconds involved in its downward course. In 10 seconds, it will travel 16.1 times 100, or 1,610 feet. In 37 seconds it will fall 16.1 times 1,369 or 22,040.9 feet. A great deal of high-altitude, precision bombing is done from about this height.

Leaving the rack, the bomb is traveling forward at the speed of the plane. If the plane is traveling 200 miles an hour, the bomb will move forward, theoretically, 294 feet while dropping only 16.1 feet in the first second. In the next second it will fall 48 feet, (16.1 times 4) and would still be moving forward 294 feet, were it not for air or wind resistance.

Consider first merely the wind. A 30-mile-an-hour wind, dead on the nose of an airplane, slows down its ground speed, while a 30-mile wind right on the tail accelerates

it. What the wind does to the plane, it does to the falling bomb.

One of the functions, therefore, of the American bombsight, which is the bombardier's mechanical brain or lightning calculator, must be that of a ground-speed meter. It has to make corrections for the "trail," or lag of the bomb, behind the airplane's speed. In practice, data on this trail is given to the bombardier in the form of a mathematical table, by which he sets his sight.

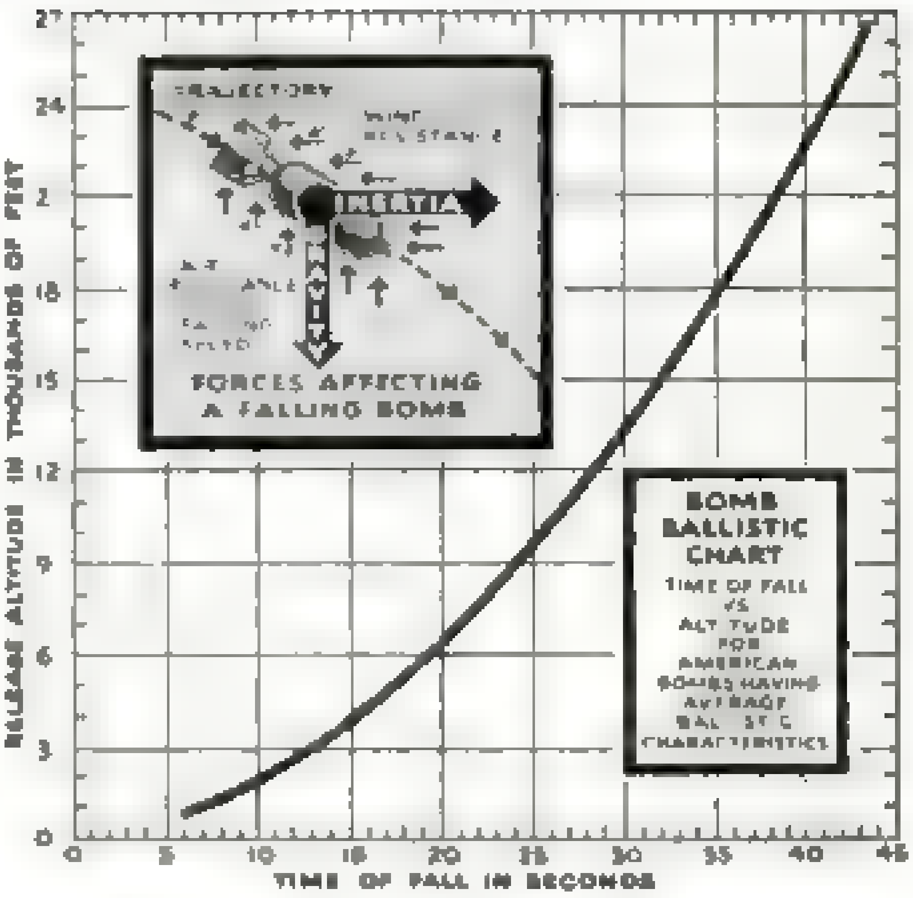
Since winds, however, do not always blow directly on the nose or tail of a speeding bomber, but often at angles to or directly across its ground track, the bombsight also must be able to correct the bombardier's aim for this "cross trail" of a bomb falling sideways from the track of the plane, but in prolongation of its axis, as well as forward at a lessening speed and downward in continuous acceleration.

The bombardier is pitching the bomb toward the target as a pitcher throws a curve across home plate, but he is pitching with plenty of mechanical aid.

No new complication sets in when the trajectory of that bomb has to be calculated on a moving target, such as a railroad train, instead of a stationary one, such as a power house.

All the factors are the same, and they will be unchanged in principle regardless of the direction of the wind or motion of the target. Further, a combination of wind and target motion does not complicate the basic picture or require any new settings. After the settings for trail and time of fall, the bombsight is concerned only with the resultant closing speed and direction of the airplane with respect to the target, and is not interested in the causes of the relative motion. All the bombardier actually has to do is to track that moving target through the cross hairs of his telescopic sight, and the machine makes the necessary calculations automatically. Maneuvering targets, like ships at sea, may evade slightly the downward path of a single sighted bomb. Pattern bombing will take care of this.

All efforts to control the flight of a falling bomb, so that it may be curved from bomb rack to target over a predetermined distance in a predetermined amount of time, will fail, of course, without mechanical



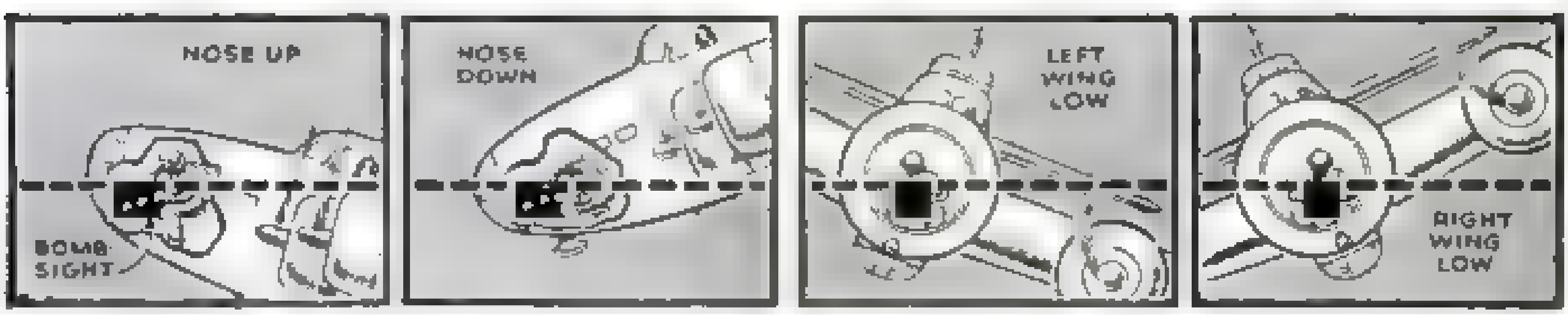
means of stabilizing the line of sight—or the bombardier's aim—during the few precious seconds of the bomb run, and of stabilizing the course of the plane as well.

The airplane, of course, no matter how skillful its human pilot may be, is capable of many movements, besides its forward course, to throw off the aim of the bombardier. It may be bounding upward, or dropping into a wind pocket. It may be rotating on upward, sideward, or forward axes by a few degrees. Every such degree will throw off the accuracy of the bombardier's aim.

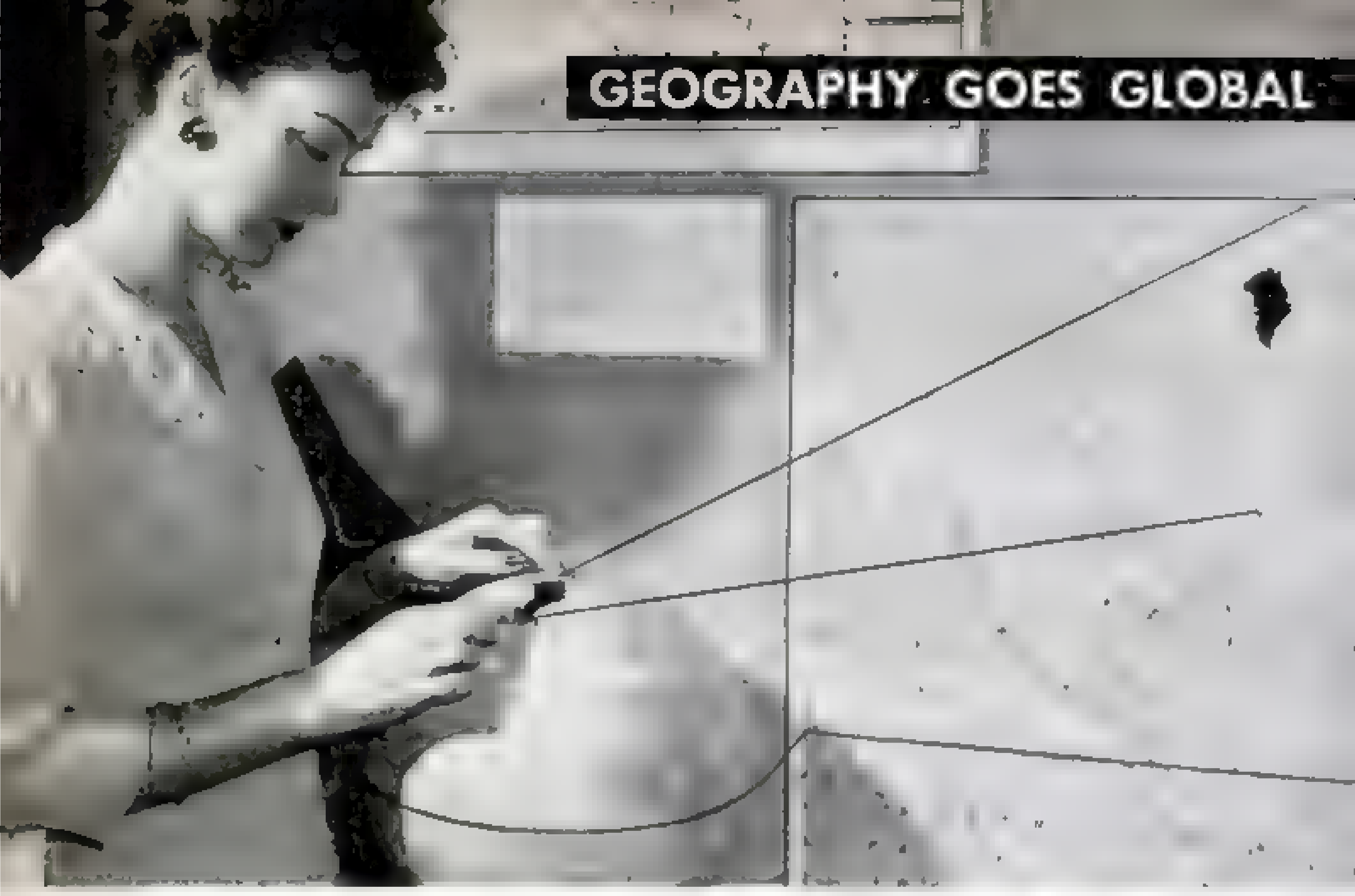
A single degree of oscillation by an airplane, during a bombing run at 25,000 feet altitude, will throw the bomb 425 feet from its correctly plotted bullseye. An oscillation of three degrees would throw the bomb 1,275 feet from its mark. U. S. airmen have found out that their planes are apt to swing at least three or four degrees in some direction during a bombing run, and swings of 15 degrees on an axis are not uncommon.

It is under such conditions that the bombsight has to be balanced, so that the aim of the bombardier may be as independent as possible of the swaying plane. To obtain the necessary stabilization, American bombsight inventors experimented first with pendulums, and then went on to the use of gyroscopes, now electrically driven. A perfectly driven rotor, untouched by outside forces, will main- *(Continued on page 212)*

GYROSCOPES KEEP BOMBSIGHT PLATFORM CONSTANTLY LEVEL

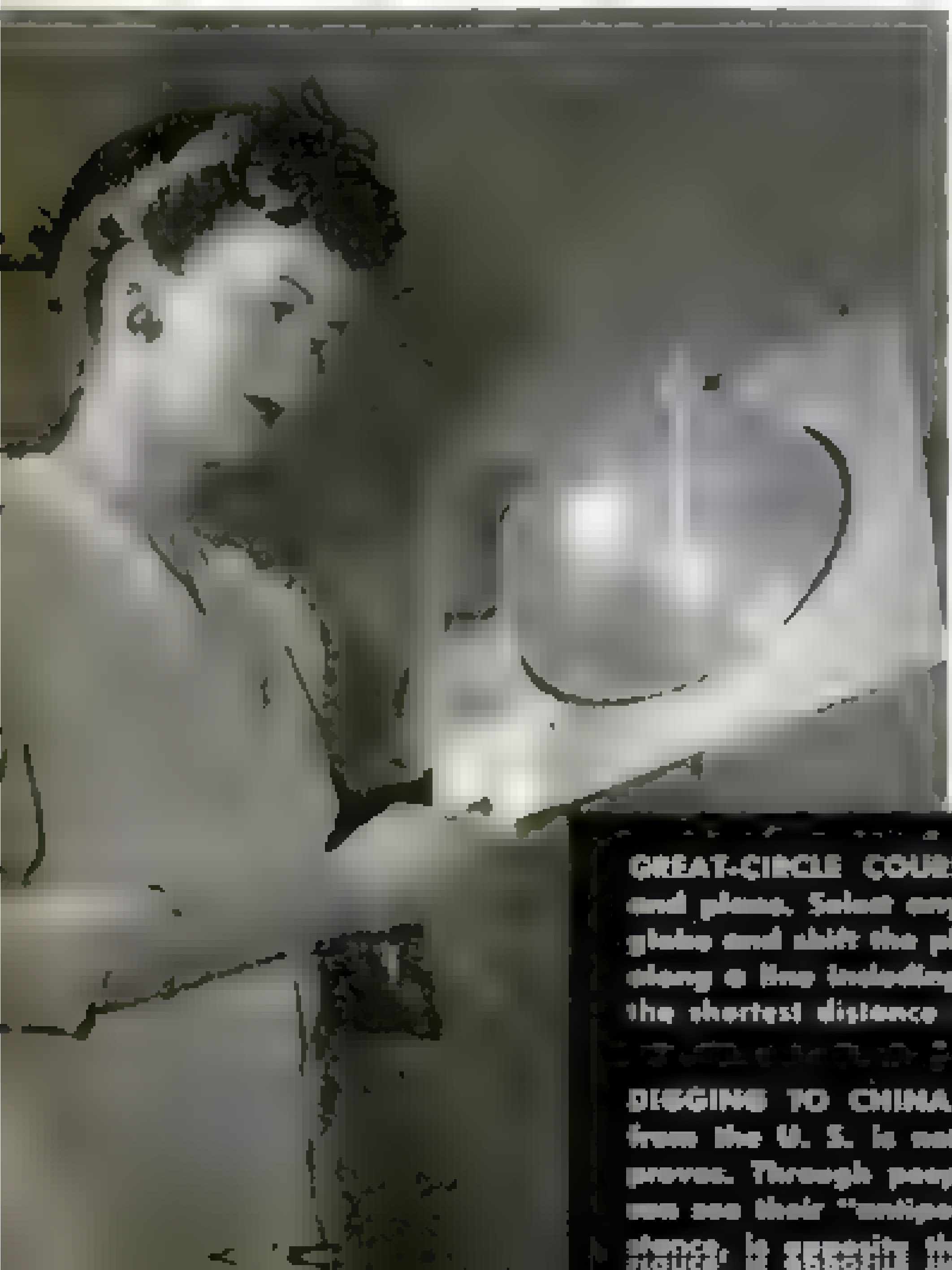


GEOGRAPHY GOES GLOBAL



Modern aviation is changing our ideas of the world we live in. To represent the earth of the Air Age, globes are much more accurate than flat maps. A recent exhibit at the Museum of Modern Art, in New York City, used globes of many kinds to show "Airways to Peace."

No flat map gives a true picture of the earth's surface. In Mercator's projection, used in most maps, meridians are drawn parallel to each other and parallels of latitude are spaced farther apart as you go north or south of the equator. The result is an increasing distortion toward the poles. Greenland, merely a large island on the globe, assumes continental proportions on a Mercator map



GREAT-CIRCLE COURSES are explained by this globe and plane. Select any two points on the surface of the globe and shift the plane so that it will bisect the globe along a line including the two points. That line will be the shortest distance between them—the airman's route

DIGGING TO CHINA through the center of the earth from the U. S. is not practical, the globe at the right proves. Through peep holes at the principal cities you can see their "antipodal points." San Francisco, for instance, is opposite the Indian Ocean near Madagascar

TO SHOW THE AIR ROUTES OF WAR AND PEACE

The world turned inside out, that's what you see when you step inside this cut-away globe built in the museum workshops. Land masses represented on the inside of the 15-foot sphere make it much easier to visualize the relationship of the various continents than with an ordinary globe that must be turned. It is especially valuable for showing how Europe, Asia, and North America are grouped around the North Pole, a key fact in the Air Age

NEW AND OLD globes are here compared. The big one is the 50-inch sphere that usually is found beside President Roosevelt's desk in the White House. Prepared for use in mapping the strategy of global war, it is the largest and most up-to-date globe of its kind and bears 17,000 place names. Its scale is 1/10,000,000 the size of the earth. The smaller globe is a copy of the oldest in existence, one made by Martin Behaim in 1492. Pre-Columbus, it shows only one ocean, the Atlantic, and there is no North or South America

Steel FOR THE TOOLS OF VICTORY

A POPULAR SCIENCE reporter takes you to the flaming furnaces of "Victory Valley," where iron ore is converted into the raw material of tanks, guns, and fighting ships.

By ALDEN P. ARMAGNAC

TOWERING 225 feet skyward from its concrete foundation, one of the largest blast furnaces in the world now swells America's war production of iron and steel. Recently erected near Pittsburgh, Pa., for the Government's Defense Plant Corporation, it represents just about the last word in ultramodern design. Push buttons control the entire system for feeding its capacious maw—with 5,500 tons daily of iron ore, coke, and limestone, which it transforms into 1,330 net tons of metallic iron. A purifying system of a new type cleans the gas liberated during smelting, which serves elsewhere as fuel, while dust reclaimed from the gas goes back into the furnace.

How steel is made, all the way from the raw materials to the finished product, may be seen in this and other near-by plants of the Carnegie-Illinois Steel Corporation, a U. S. Steel subsidiary. Through its courtesy and with necessary War Department permission, fascinating highlights of the process are described and illustrated here from first-hand observation—a number of them, it is believed, for the first time.

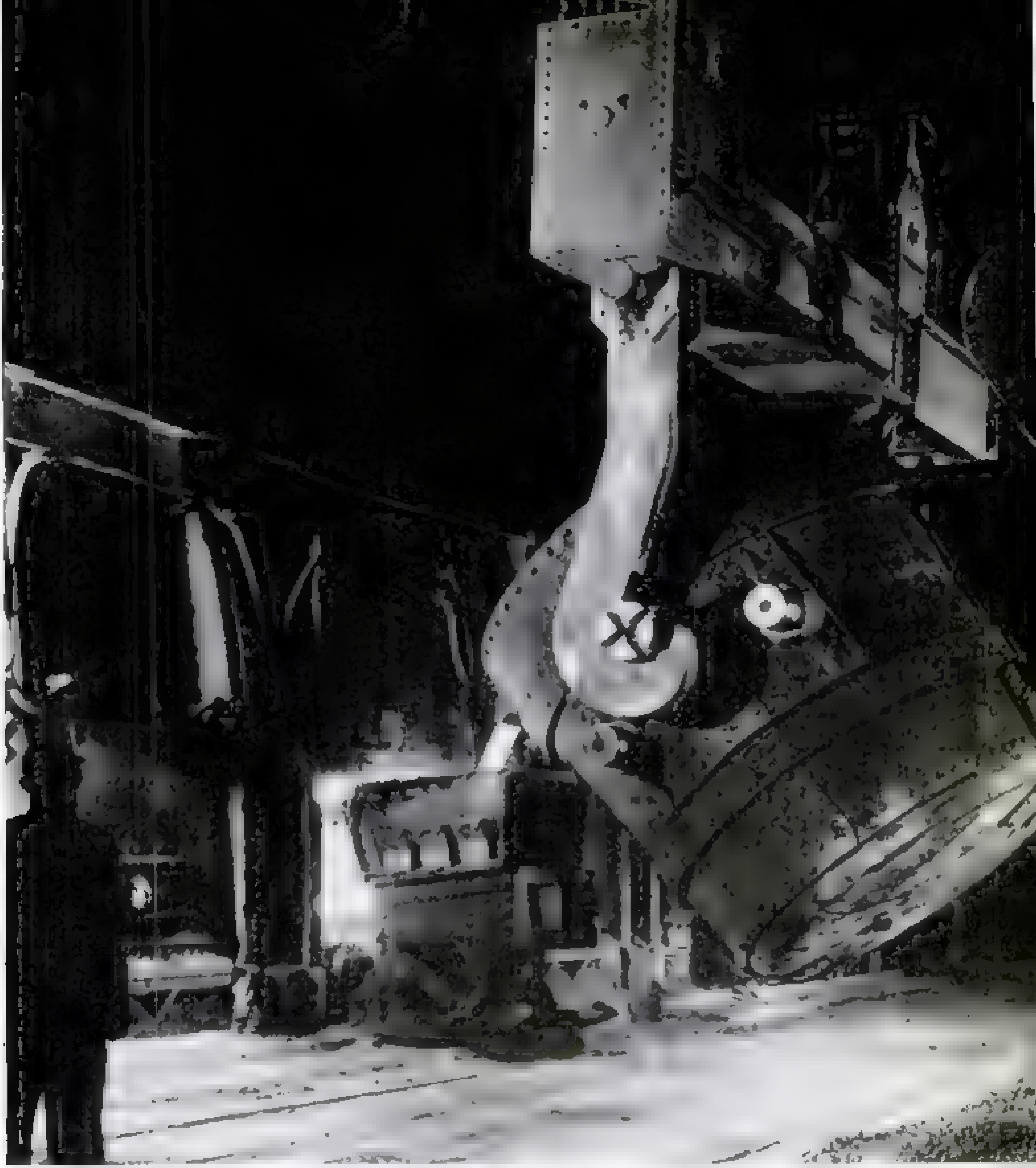
Act I, scene 1 takes place in what might be a Hollywood movie setting—a subterranean passageway near the new blast furnace. A single track occupies the center of the tunnel. At your left, a panel twinkles like a Christmas tree with blue, red, amber, and green indicator lights, interspersed with control buttons of silvery metal. On your right, your eye follows a long row of bins with hand levers at their spouts. At the ear-blasting sound of a whistle, you jump out of the way of an open electric rail car with a red headlight. A "larry car," they call it.

Its operator grasps the counterbalanced hand levers, and a stream of ruddy iron ore pours into a hopper on the car, until a weighing dial shows that enough has been loaded. Then the car rumbles along to the control panel. A click of a safety release indicates that a furnace-charging car, or "skip," is in a pit below. Now the larry-car operator turns a handle, and the pile of ore drops into the skip. Then he taps a large button labeled "Skip Start." The loaded skip shoots upward and out of sight. Other loads follow, until a red light on the panel indicates a full charge.

Above ground, you can watch the four-wheeled skips ride to the top of the blast furnace on one of the world's steepest railways, pitched only 10 or 15 degrees from the vertical. Two skips serve each furnace, dumping their contents into it through a pair of cones or "bells." These serve as an air lock to prevent escape of gas. Their shape also helps to distribute the load evenly, until the furnace is filled from top to bottom with a reasonably uniform mixture of about three parts of ore, two parts of coke, and one part of limestone. A fourth essential ingredient—hot air injected near the bottom—puts the "blast" in a blast furnace.

To provide this hot air, burning gas and air pass alternately through checkerwork flues in huge "stoves," each one nearly as large as a blast furnace itself. When the brickwork of one stove is scorching hot, the gas is turned off, and blowers direct air through it to the furnace. By the time it cools appreciably, another stove is ready to take over the "fireless cooker" process. The blast entering the furnace is hot enough to make wood burst into flame.

A fire that never goes out, except in case of a prolonged shutdown, burns within the massive firebrick lining of a blast furnace's steel shell. Coke, fired by the hot-air blast,



Molten iron, fresh from the blast furnace which has extracted it from the ore, pours into a huge open-hearth furnace where it will be converted into steel. The giant ladle spills the glowing liquid into a portable trough that guides it through one of the five charging doors. (Photo courtesy U.S. Steel Corp.)

provides the fuel. Its gases also extract oxygen from the iron ore, leaving molten iron, which drips downward through the charge and collects in a pool at the bottom. Limestone melts to form a free-running flux, scavenging impurities from the ore and coke, and floating on top of the iron. By drawing it off through an outlet above the level of the iron, about every two hours, this slag is easily removed. Crushed or granulated, it makes an excellent land-fill material, railroad-track ballast, and concrete ingredient.

Squinting into the hearth through a small observation port, a blast-furnace expert, called a blower, judges when the molten iron is ready to tap. This spectacular operation takes place every five hours, on the average. Like the removal of slag, it has nothing to do with charging the furnace, which is constantly refilled as the mass within it descends. *(Continued)*

At the blower's word, workmen burn out the iron that has solidified in the tap hole. The incandescent metal appears—first as a slow trickle, then as a gushing stream. It races across the floor, showering sparks, guided by channels of sand. Its destination may be a casting machine, where molds on an automatic conveyor form it into solid "pigs" weighing 50 to 100 pounds apiece. More likely, it will be poured into refractory-lined ladle cars, and hauled by rail—while still molten—directly to the furnace that makes it into steel.

Just what is the difference, anyway, between iron and steel? Crude or "pig" iron, just as it comes from the blast furnace, contains a large percentage of carbon and chemical impurities which make it brittle. In refining it, the carbon content drops to a point within rigidly specified limits; impurities go out; and, for special purposes, other metals may be added. The result is the tough, malleable product called steel.

Recent figures of the American Iron and Steel Institute rate U. S. steel-making capacity at 91,000,000 tons yearly—80,000,000 tons from open-hearth furnaces, 6,000,000 tons from Bessemer converters, and 5,000,000 tons from electric furnaces. Unlike the continuous operation of a blast furnace, all these types consume their entire contents to make a heat of metal. Which process will be used depends largely on the kind of ore available. In this country, the ore favors the open-hearth method.

A battery of 11 great furnaces, built by Carnegie-Illinois for the Government-financed war expansion program, illustrates up-to-date open-hearth procedure. Since it takes each furnace about 11 hours to make a heat of steel, the set of them will average about one heat an hour.

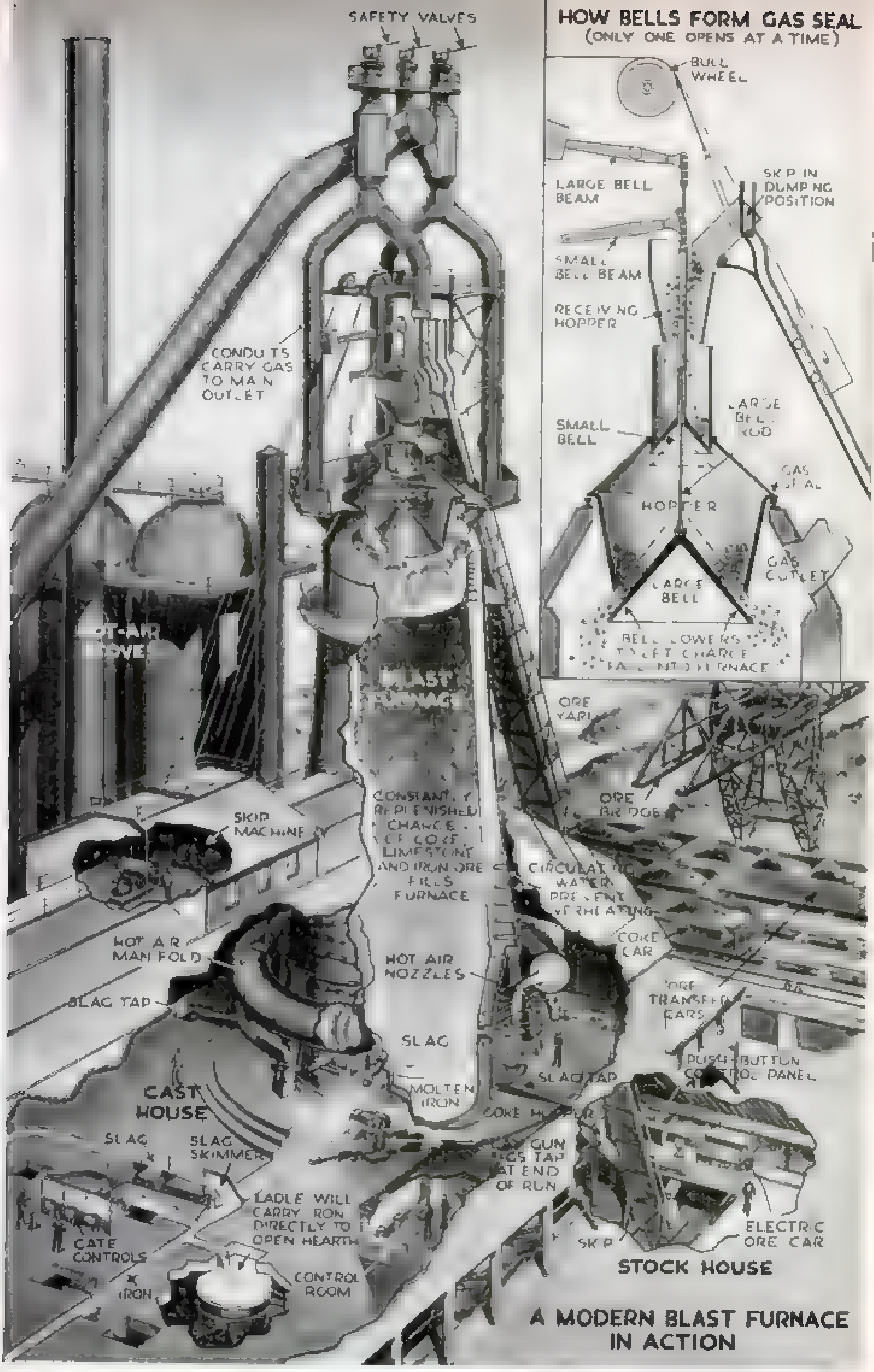
Giant oil burners, one at each end of a bathtub-shaped hearth 56 feet long, throw a sheet of flame over the contents—molten iron from the blast furnace; iron ore, which "burns out" or oxidizes part of the carbon; scrap steel, which further lowers the carbon content by dilution; and limestone, the artificial lava which, in boiling, brings up the steel through the slag to meet the heat of the burners' blast. Inserting the enormous bulk of solid materials through the five charging doors, a Herculean task for men with shovels, has been made easy by modern use of a charging machine. Its traveling arm simply thrusts a loaded charge box through an opened door of the furnace and empties the contents within. Molten iron enters by a portable spout. Since arriving from the blast furnace, it has been blended with other batches, in a huge globe or cylinder called a "mixer," to obtain a more uniform content.

When a three-foot-deep pool of molten steel has collected in the open-hearth furnace, and a final analysis shows it to meet the specifications of the order, it is ready for tapping. Workers break open an outlet, and the fiery stream flows into a ladle big enough to hold the furnace's entire capacity of 225 tons.

In common practice, a crane now picks up the ladle, and a valve-equipped hole in its bottom pours the steel into ingot molds. An innovation at the Homestead plant of Carnegie-Illinois is the use of a small, 35-ton "basket ladle" as an intermediary. Filled from the big ladle, it speeds up pouring steel without spurting or spattering, because its comparatively low hydraulic head of liquid metal permits a much larger bottom opening. Also, the two-ladle system gives the steel a double skimming to free it of any remaining slag.

As in a blast furnace, the bulk of the slag has already been eliminated by tapping it from a separate furnace outlet, or by letting it overflow from the big ladle into a smaller

Ultramodern push-button panel used with "larry car" for charging the mammoth new blast furnace of the Defense Plant Corporation near Pittsburgh. Ore drawn from bins is dropped through a grating into the skip car which will carry it to the top of the furnace. Opposite drawing shows how the blast furnace works



A MODERN BLAST FURNACE IN ACTION

ladle near by. Homestead engineers pride themselves upon a system that shunts slag to the front and rear of the furnace at once, a novelty that hustles away the unwanted material at the critical moment of pouring.

Traveling in pairs on small rail "buggies," the ingot molds that have been filled with molten steel get hauled to outdoor yards, where the metal solidifies. Then a crane-operated "stripper" lifts off the molds by their side lugs, pressing down at the same time on the ingot if it resists being unveiled so abruptly.

Ingots represent the largest pieces of steel that can be handled conveniently by cars and powerful cranes. No watch charms, they range in size from about 2¼ tons upward, depending upon the capacity of the blooming or slabbing mill that will shape them.

Because of its brilliant display of fireworks, a Bessemer converter probably appeals to most laymen as the symbol of steelmaking. Actually its capacity of 10 to 25 tons of metal does not begin to compare with the heat of more than 200 tons produced by an open-hearth furnace. But the steelmaking process invented by Sir Henry Bessemer has the outstanding advantage of doing its work in a matter of minutes instead of hours.

Shaped like a pear, with a large orifice at the small end, the converter may be swung through a wide arc on its massive trunnions. Tilted over backward for charging, it receives a ladleful of blast-furnace molten iron. Then it swings upward, while pipes in the bottom admit air with sufficient force to keep them clear of metal. Now the air blast, which does the steel-making, rises to a roar. Actually its oxygen is burning up, or oxidizing, the carbon and other unwanted substances in the iron. Since this simple reaction generates great heat, no fuel is required. At the height of the "blow," the mouth of the converter emits a 30-foot jet of flame, visible at night for miles. As it dies down, operators on a control platform called a "pulpit" shift levers that tilt the converter forward and downward—to empty its steel into a ladle for transfer to ingot molds, and to rid it of clinging slag.

An electric furnace is the steel man's pet. Its heat of a few tons—once about five, now from 30 to 100 or more—does not greatly exceed that of a Bessemer converter, and takes from six to 10 hours to complete, but it is some of the finest steel made. Because of the extremely precise control of temperature and ingredients, electric furnaces are particularly suited to produce modern alloy steels.

Suppose you want steel to make exhaust pipes for seaplane engines—one of the toughest of orders to fill, because the metal must resist the terrific corrosive effects of red heat and of salt-water spray. The metallurgist specifies stainless steel, plus titanium, a comparatively rare metal, in sufficient percentage to enhance the desirable qualities of plain "stainless."

Now an electric-furnace man carefully figures out the weights of the various ingredients to fill your order. There will be a considerable amount of "selected scrap"—chrome, nickel, and titanium steels. Much or all of this consists of waste metal such as machine-shop turnings recovered in one of the maker's own plants, which gives him the advantage of knowing its exact composition. To this will be added the proper quantity of "low-met scrap"—common steel of good quality, low in carbon, phosphorus, and sulphur. The charge may also contain some iron ore.

After the operator has raised the electrodes of the furnace—big, round sticks of graphite about two feet in diameter—a charging machine unloads the ingredients on the bowl-shaped hearth. Then the operator turns on the current, starting at low voltage, and slowly lowers the elec-

Reheated to incandescence in the soaking pit, a steel ingot starts for the rolling mills that will shape it into useful form. An overhead crane grasps it with its husky tongs

THE LANGUAGE OF STEEL

ANNEALING. Heat-treating to eliminate hardness and brittleness.

BILLET. Square or round steel shape rolled from ingot or bloom. Smaller than bloom in cross section.

BLOOM. Square-ended shape rolled from ingot. Used for reduction to rails, bars, and structural beams.

CASTING. Pouring liquid metal into a mold.

FLUX. Material, such as limestone, which helps to separate smelter slag from metal.

BLOOM

FORGING. Shaping metal by heating and hammering.

HEAT. A batch of molten metal.

HOT METAL. Iron delivered in molten form to a steel-making furnace.

INGOT. First convenient handling shape for steel. (Ingots commonly vary in size from 2½ to 20 tons.)

INGOT MOLDS. Receptacles for shaping ingots.

IRON. Metallic element smelted from iron ore.

PICKLING. Cleaning steel with an acid bath.

PIGS. Small castings of blast-furnace iron.

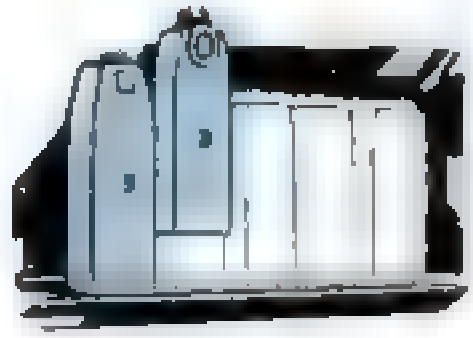
PLATE. Wide, flat steel ranging in thickness from heavy forged plate, such as warship armor, to gauges rolled slightly heavier than sheets.

P. S. I. (or PSI). Pounds per square inch. Used to specify tensile strength of steel.

QUENCHING. Cooling hot steel suddenly, in water or oil, to harden it.

FORGING

INGOT MOLDS



SHEET. Gauges of wide flat-rolled steel ranging between plates and tin plate.

SLAB. Flattened shape made from ingot. Used for rolling sheets and plates.

SLAG. By-product of iron and steel making.

SMELTING. Extracting metal from its ore by heating, as in a blast furnace.

SOAKING PIT. Gas-heated furnace where ingots are raised to high, uniform temperature for rolling.

STEEL. Refined, malleable alloy of iron and carbon. Content of latter ranges from 0.1% (LOW-CARBON STEEL, easily machined) to upward of 0.85% (HIGH-CARBON STEEL, which can be made very hard by heat treatment). ALLOY STEELS also contain other metals that give them special properties. OPEN-HEARTH STEEL, BESSEMER STEEL, and ELECTRIC STEEL take their names from the three major steel-making processes.

HOT METAL

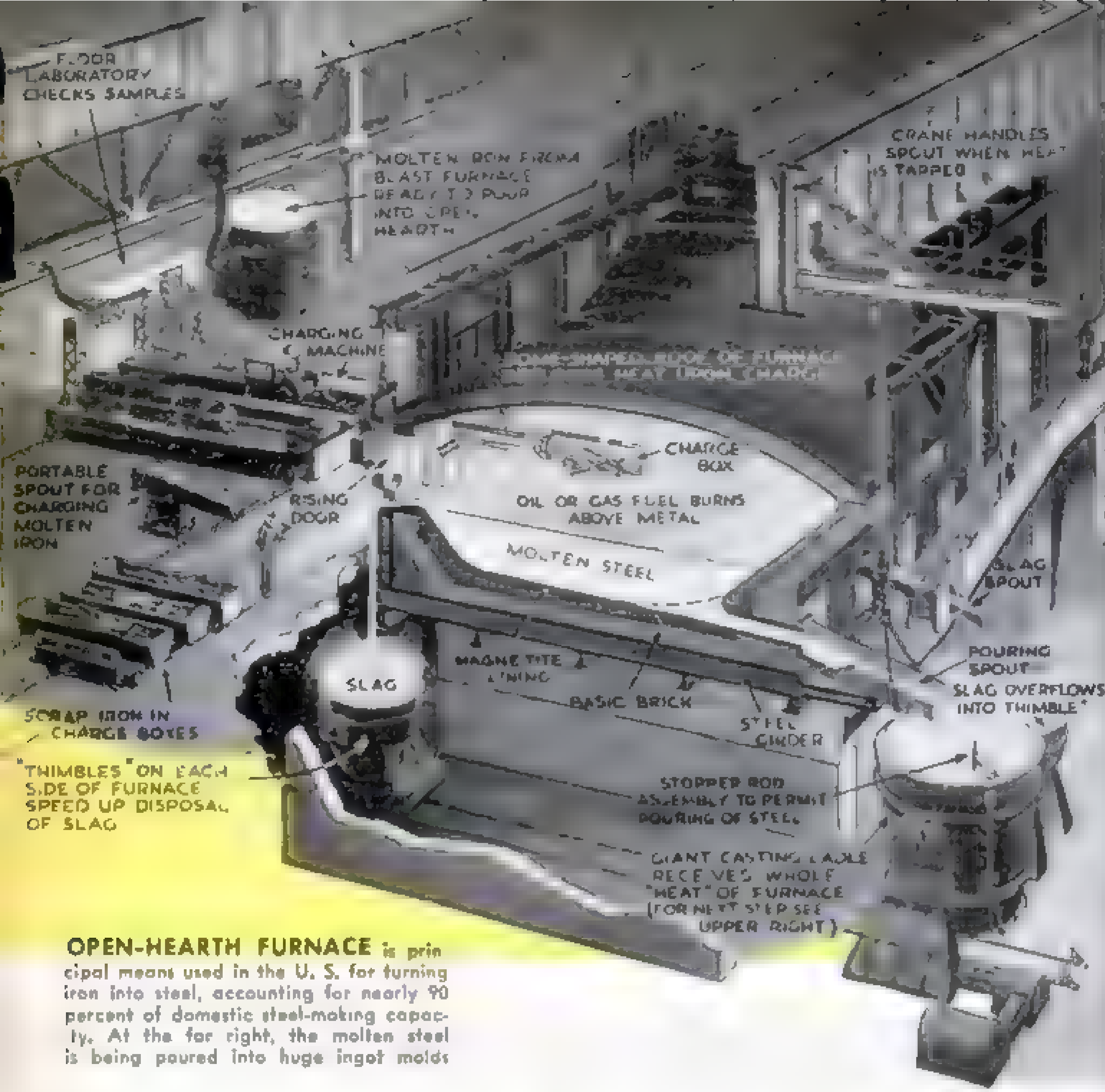
STOVE. Large structure supplying hot air to a blast furnace.

STRIP. Narrow, flat-rolled steel about 1/16 inch thick.

TEEMING. Drawing off a heat of molten metal.

TEMPERING. Heat-treating to impart desired hardness and toughness to steel.

TENSILE STRENGTH. Maximum stress or tension that steel can withstand. Ranges from about 50,000 p.s.i. (pounds per square inch) for softest steel to 360,000 p.s.i. for watch-spring wire.



OPEN-HEARTH FURNACE is principal means used in the U. S. for turning iron into steel, accounting for nearly 90 percent of domestic steel-making capacity. At the far right, the molten steel is being poured into huge ingot molds

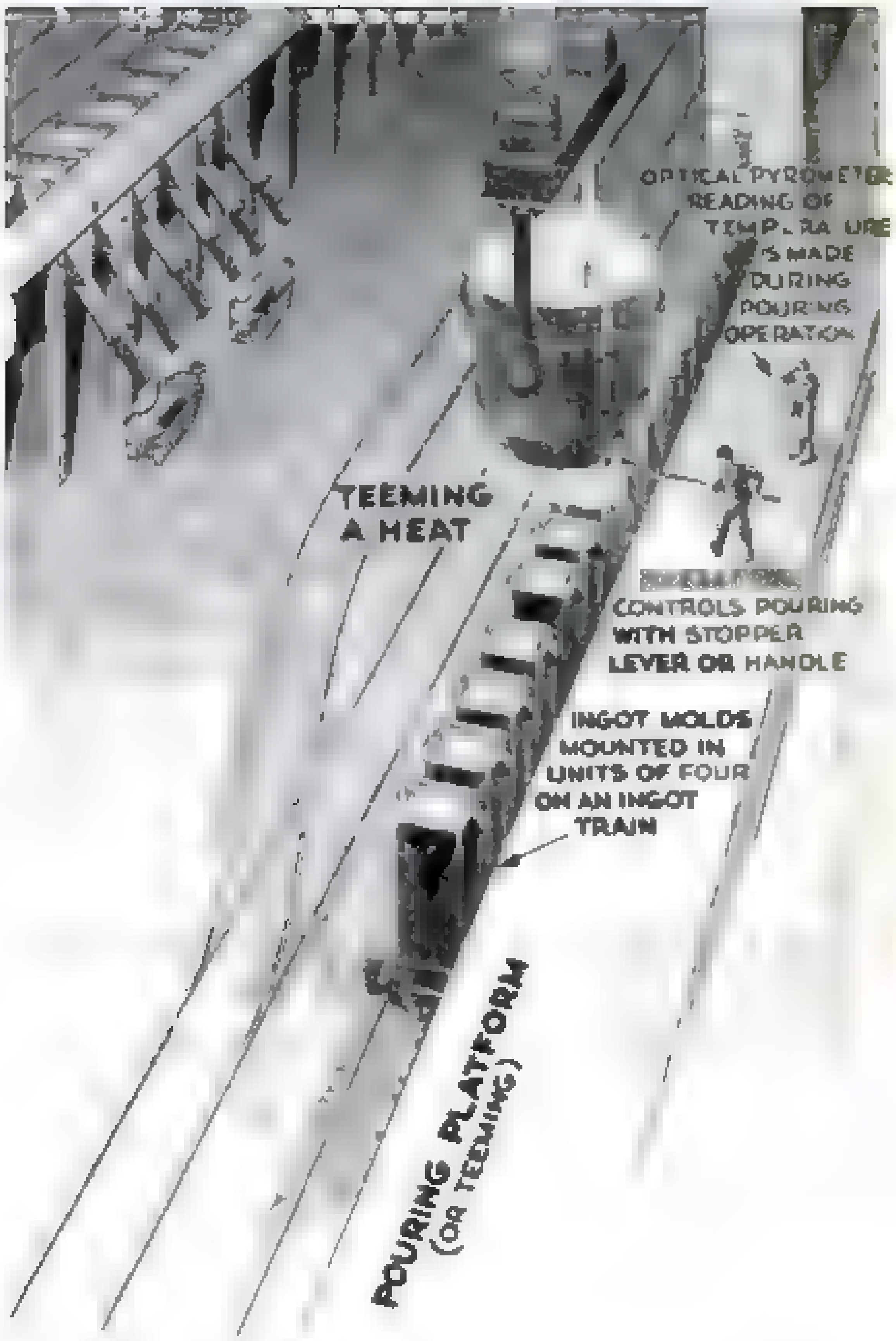
trodes toward the charge with the aid of a small crane. When the electrodes barely touch the charge, electric arcs leap between them and the metal. The operator builds up the power to full voltage. Melting spreads from scattered puddles until the whole mass becomes liquid. Distribution of heat is believed to be aided by a curious electrical phenomenon, circulation of the metal in response to the heavy current passing through it.

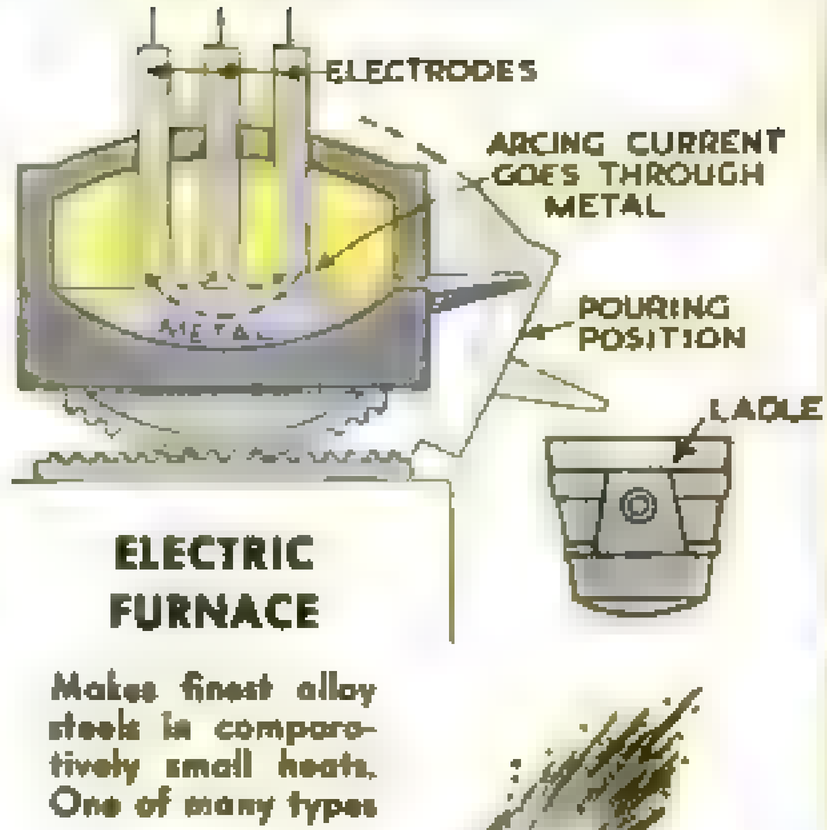
Frequent sampling calls for adding small amounts of various materials, until the composition is just right and the steel is ready to tap. Then, unseen machinery tilts the furnace and its whole surrounding platform. Metal pours from the tap hole into a waiting ladle, which transfers it to the ingot molds. A typical ingot of electric steel weighs seven tons.

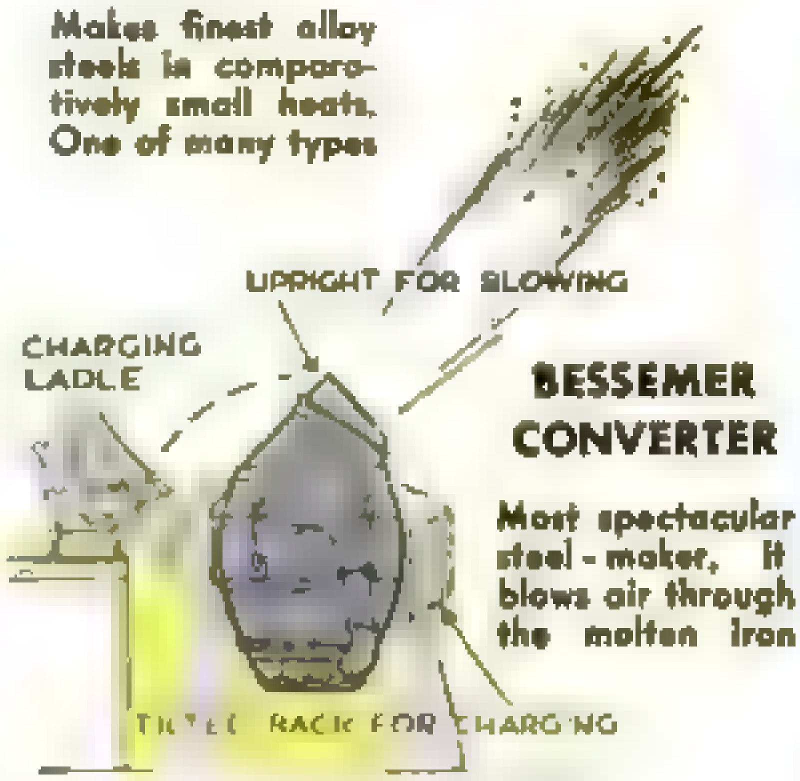
Now the ingot, by whichever process produced, goes to a soaking pit. Here blast-furnace gas reheats it to incandescence for passage through the many rolling mills that will reduce it to its final shape

Two blasts from a signal horn. The slabbing mill is calling for metal. Over comes a glowing ingot to buck in vain against the mighty rolls—to be flattened between them and passed along, bumpety-bump, to other rolls that thin it again and again. Eventually it may end as coiled strip for manufacturing food cans. If the ingot's first stop was the blooming mill, it would take on a nearly square cross section, from being turned on its side between passages through the rolls. It might finally turn out as wire.

Where the home front is concerned, steel production is a major event on the war program. Industrial heads have been put together to scheme new ways for expanding the capacity of the steel mills, and it is possible that the output, at present 91,000,000



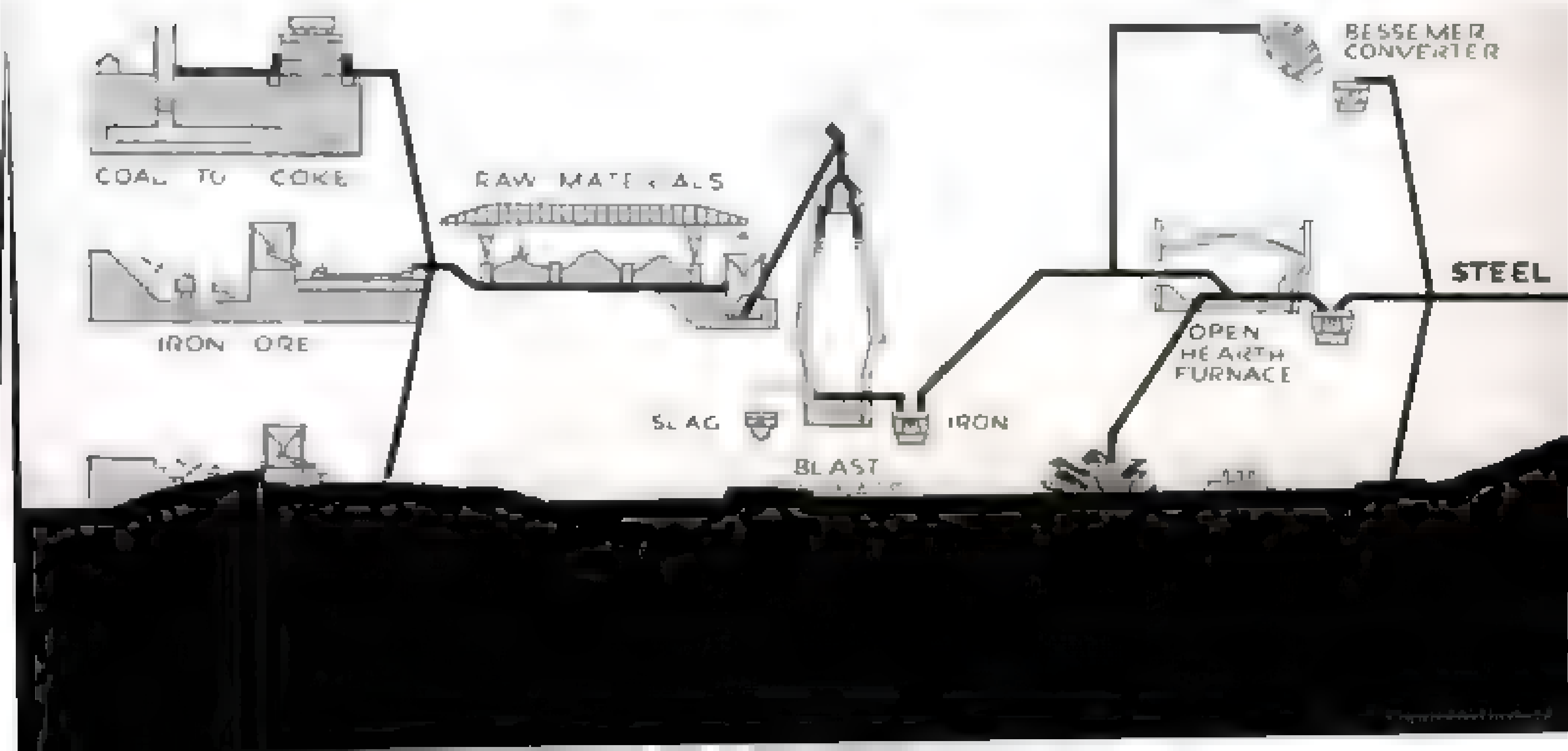




tons a year, may in the next six months reach the staggering total of 96,000,000. Considering the daily requirements of steel tonnage, this goal is neither extravagant nor surprising. Every 24 hours the nation's war effort calls for enough steel to build and equip two giant battleships and more than 1,000 four-motor bombers such as the Liberator and Fortress.

Four more signal blasts, "Faster!" There's a war to be won—and who knows it better than the men in the miles of steel plants that light up the Monongahela River by night? "Victory Valley," they call it, and with reason.

THESE ARE THE STEPS IN THE PRODUCTION OF STEEL



Previewing Your Postwar Car

HIGHER POWER FROM SMALLER ENGINES, EXTRA ROOMINESS, AND SIMPLER OPERATION ARE SOME OF THE GOALS TOWARD WHICH BUILDERS ARE AIMING

Don't look for a miracle car as soon as the war ends. The car makers have plans, but they intend first to give you a replica of the 1942 model—with improvements—the moment that they can set up their old tools and dies. Alfred H. Sinks, in researching this article on postwar cars, not only talked to established manufacturers, but also saw designers, dealers, airplane makers, and others who are planning to enter the automobile field. The consensus, with few dissenting, was that the first cars will be turned out as fast as possible to fill the backlog of demand. But after that, many war-born designs and materials are on the books. How that next new car will look—and what it will do on the highways—Mr. Sinks reveals in this description of cars to come.

By ALFRED H. SINKS

Drawings By STANLEY BATE

WHAT will it be like, the next new car you buy? The automobile industry has given part of the answer. The first new cars to roll off the production lines will be 1942 models, with minor changes. Your wonder car of the future will have to simmer on the back of the stove while the manufacturers hurry to catch up with the immediate postwar demand.

Tools and dies for 1942 models—the last made before our automobile plants were converted to war work—are now in storage. Within four to six months after war production slacks off, dies can be moved back onto the factory floors, machines can be set for automobile parts instead of weapons, and cars can begin to roll. To get ready to manu-

facture a brand new model might take at least a year, and that would be valuable time to lose when the floodgates of postwar demand for automobiles are opened.

But after that first new car, then what? The whole transportation world is throbbing with changes to come. New discoveries pouring from laboratories and war industries are smashing conventional ideas of construction and design, and it is certain that they will have tremendous influence on automobiles. Designers are even now working overtime to bring their plans for future cars in line with the latest developments in engineering.

How soon will that next car come? Not all are agreed. Within a year or two after the war ends in Europe, some independent designers declare, you'll be driving cars that are mechanical miracles. As soon as the Government lets them have the materials, say others, or as soon as factory space and machines can be spared from war production.

On the conservative side stand most of the big automobile manufacturers. Dream cars will be a long time coming, they insist. There will be no revolutionary steps, they say; and progress will be evolutionary in the future just as it has always been in the past.

Whatever he may tell you, your automobile dealer himself is dead set against rapid changes in design. He sells used cars as well as new ones. If models change too rapidly, the used cars soon begin to look like antiques and lose resale value.

Then, too, the public is going to have a say. It is public taste most of all, the manufacturers declare, that dictates design. The public will not accept radical, sudden changes in appearance, many of the established makers believe. And in the past it has been what a car looked like on the outside, not what it was like inside, that

attracted most buyers. There may be a revaluation of this idea, though, when the new cars go on sale, for the sponsors may find that, with millions employed in industrial plants during the war, Americans and especially American women have become more machinery-minded.

Public imagination has been fired by war technology. There is the versatile jeep—not so much to look at, perhaps, but a wonder on the road and even off the road. Tanks, half-tracks, and motorized gun carriages have proved that they can take it. And what of the sleek beauty of our fighting planes? Will the public want some of that transferred to its automobiles? Many of the designers think so. And they think, too, that the public will demand some of the engine performance of modern bombers and fighters.

Already teardrop and airfoil lines are prominent in the designs that are being considered. They will replace to a large extent the so-called streamlining that before the war had encumbered many of our models with metal over wasted air space and with useless chromium decoration. Manufacturers would have eliminated this chromium plate long ago if careful surveys had not indicated that plenty of "brightwork" sold secondhand cars. The break at the end of the war may give them their chance.

Undoubtedly the new car will be shorter and easier to turn than our old models. Extra length and wasted bulk have lessened maneuverability in the past. But though the new car may be smaller, it will be much roomier because of its different shape. Its hood will be shrunk to a fraction of the present size, or it will be gone altogether, and its bumps and angles will give way to the clean lines of a fast fighter plane. There will be no wasted space under the hood, and the new motor will be much smaller.

Fenders are slated to disappear entirely, and bumpers will extend completely around the car, offering some protection in sideswipes as well as in front and rear collisions. Over the wheels, these bumpers will be in sections that can be removed easily when a tire is to be changed. Instead of being made of rigid metal that transfers the shock of impact to the body, bumpers will be flexible and will absorb a jar, minimizing damage to the car.

The windshield and windows will curve with the contours of the body. They may be of laminated glass, or they may be of clear, transparent plastic that will be as strong as the body of the car and permit a construction with no corner posts, thus providing complete vision without blind spots.

In fact, the plastics industry is keenly interested in your new car, and plastics may play a big part in its design. Opaque plastics, with the color molded right into the material, would do away with the expense of painting. Clear plastics can now be toughened so that they resist abrasion nearly as well as glass. Used in place of glass, they would save weight and increase safety.

Whatever the material of the body, it will make your car lighter. Aluminum and magnesium will be far cheaper and more abundant than seemed possible a few years ago. They may be used in the body and are sure to be used for crankcases and other engine parts and for sections of the chassis. Bonded, compressed plywood, such as made history with the Mosquito bombers, is being given serious consideration for bodies. It has proven strength, durability, and lightness.

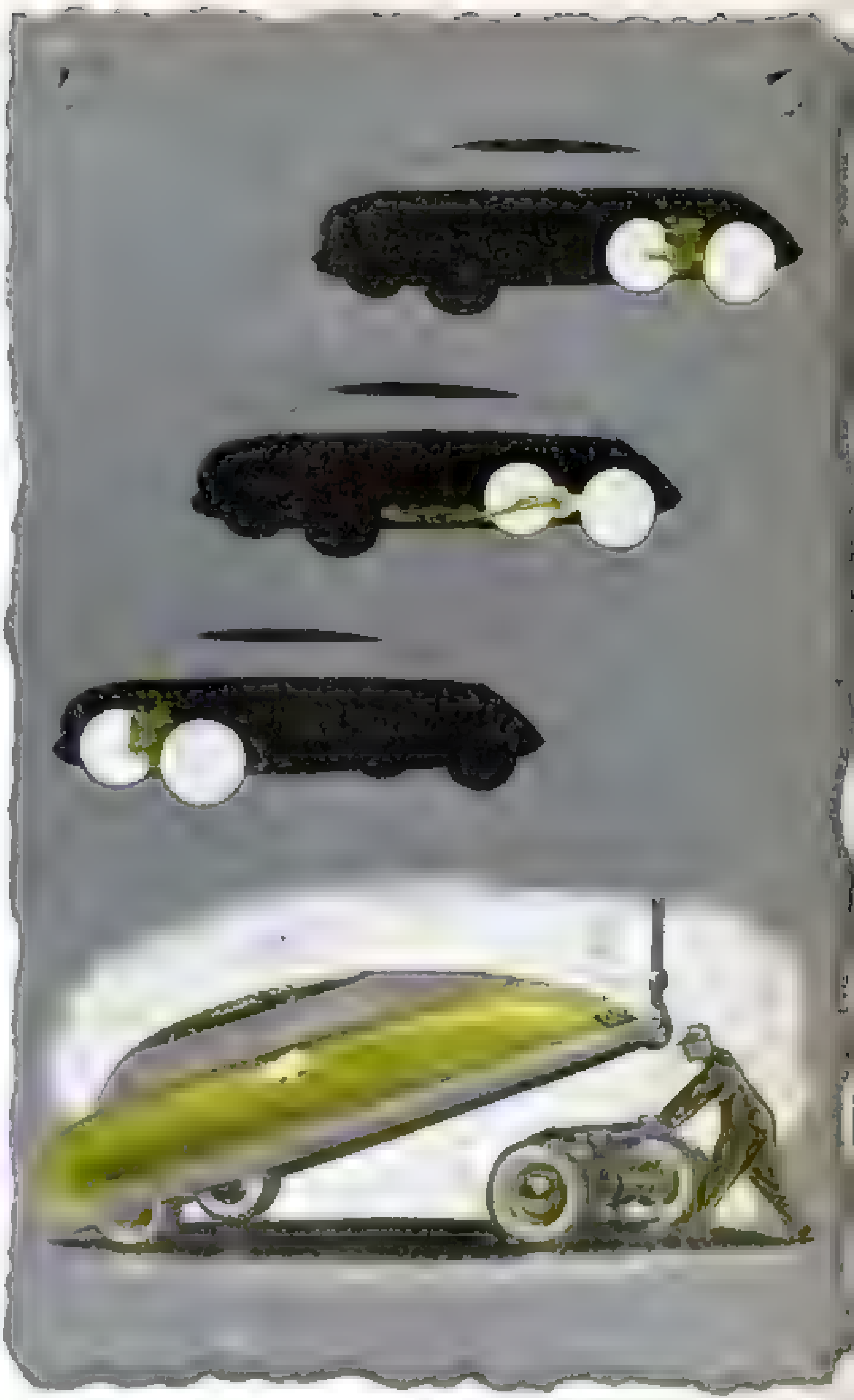
This dual-purpose intake air-conditions the car for passengers and supplies air cooling for the engine

So much for the outward appearance and frame of your new car. What about its motor and its performance? With continued improvement in fuel quality and progress in the engine builder's art, you will see the automobile engine shrink to teakettle size. It will be entirely new, designed with small cylinders and a high-compression ratio to utilize 85 to 90 octane gasoline. Such gasoline will be available in large quantities after the war, and petroleum men expect octane values to climb rapidly while engines grow smaller. You can count on more and more miles per gallon from these new engines, with no top limit yet in sight. Moreover, you'll probably have a supercharger to give you an extra push up a steep incline or a burst of extra speed for a fast getaway.

Shall the engine be air-cooled or liquid-cooled, V-type, in-line, radial, or pancake? Where shall it be placed—front, rear, or center? Your tiny engine will be mounted where it will be least in the way. It may be tucked away in the rear, still leaving room for a luggage compartment above it. It may be a pancake type under the floor near the center of gravity. Or it may ride inconspicuously over the front axle. One new design calls for a small radial engine mounted over each wheel. Another contemplates the use of a powerful pump that will drive a set of turbines, one on each wheel.

Motors will be designed to save you time and money by being made easy to service. One new engine can be given a complete overhaul in two hours. A "top overhaul the kind that generally takes your garageman a day—can be done in 45 minutes

One automobile manufacturer is working on a model in which the engine and the rear wheels are a single unit, fastened to the body by four bolts. You drive into the garage. The mechanic jacks up the rear end of the car, unfastens the motor unit—wheels and all —and rolls it away. Then he trundles up a "loaner" unit, bolts that in place, and away you go. A complete overhaul of your engine will take no more of your time than a 10-minute stop on your way to work and



The compact high-compression engine may be on the rear axle, under the floor (in pancake form), in front, or on a quickly detachable rear unit

another 10-minute stop on your way home.

You will never need to bother about filling the radiator. Your motor will either be air-cooled or it will have a sealed cooling system that will need no draining, cleaning, or other attention. Many parts of the engine may be permanently sealed. Ignition systems that cannot get out of whack are now within reach. Even the carburetor may give way to an entirely new device that will inject the liquid fuel directly into the cylinders.

Once every 20,000 miles or so you may still have to change the oil. But your main lubrication worry—burned-out bearings—will be forgotten. Self-lubricating bearings made through the magic of the new powder metallurgy are one answer. Other designers favor bearings made of indium or silver, or steel roller bearings such as are used in aircraft engines.

Crankshafts, connecting rods, gears, and springs will probably be built of the new NE "lean alloy" steels. Developed under pressure of war scarcities, these steels are light and strong. Through what the industry calls the "vitamin" treatment, they are hardened by the addition of inexpensive chemicals instead of expensive alloy metals.

The steering wheel will be modeled after those of our latest bombers—a light segment instead of a full wheel—and will not crowd you when you get in or out. The old shin-barking steering post was slanted for leverage. Power steering will make that unnecessary. This power steering is in itself a remarkable achievement; it means that with just slight pressure, you can guide your car through the hardest turns. The work is done for you by the power system built into the steering gear.

The power-drive principle will also be found in the brakes. There will be just two pedals on the floor of the new car—a brake and an accelerator. Because of power braking, only light pressure will be needed to bring you to a smooth stop. Don't look for a clutch pedal or a gear-shift lever. Automatic transmission—born of the device that swings the giant guns on our battleships—is definitely on the books for future cars.

Eyelids on your headlamps may be lowered during the day, protecting the lenses from dust, and raised at night to reveal powerful lights no larger than the head of a good-sized flashlight. Accidents and discomfort from the blinding glare of the headlamps of an approaching car will be done away with. A simple photocell device will dim the lamps of both cars automatically, leaving plenty of light to see by. With a small knob on the dashboard, you will be able to swing your headlamps to either side. In rain, snow, or sleet, a new device will clean the glass without a windshield wiper darting back and forth and interfering with your vision.

Headlights, hooded by day, may be dimmed automatically by photocells

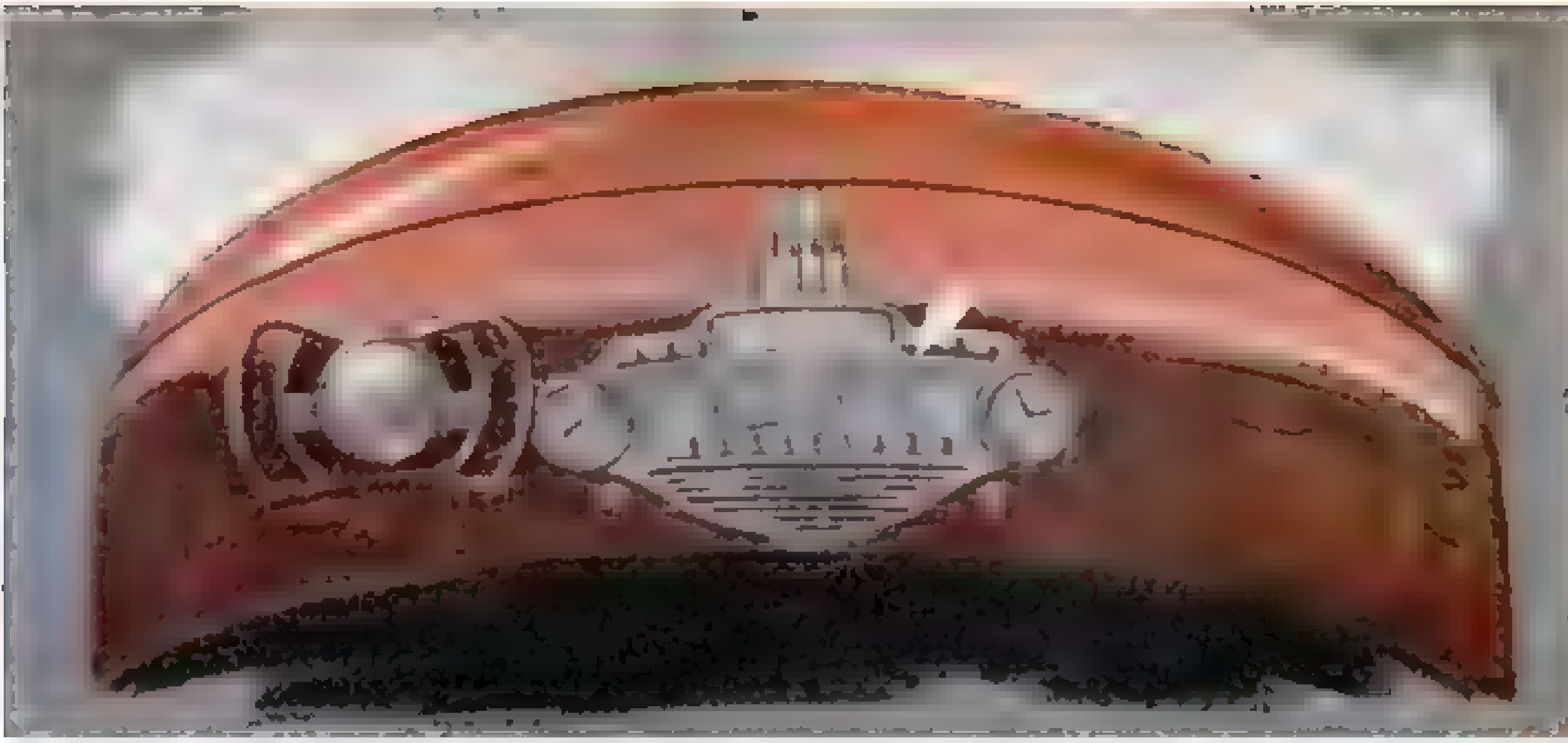
Your future car will give you all the thrills you can ask. It will travel like the wind and stop on a dime. But the risk and discomfort that used to go with high speed will be missing. Marvelous new spring systems will smooth out the bumps as the dead weight of the old models never did. They will be variable, so that the car will ride as well with a single passenger as with four or five.

Rubber springs have been developed. One is the B. F. Goodrich Co. "Torsilastic" spring; another employs an air-cushion principle. Both take the tossing out of driving over rough roads. With tires that have less bounce adding still further to your comfort, a bump will only make you sink deeper into the sponge-rubber cushion of your seat.

Handsome, easy-cleaning fabrics made of nylon, spun glass, or a host of other synthetic and natural materials that had not even been thought of a few years ago will cover the seats. Some models may have movable chairs; others will have a rear-seat arrangement that can be made up as a couch or bed.

In present-day cars there are as many as 125 different parts of natural or synthetic rubber. Both of these materials probably will play an even bigger role in the future cars. Builders will have to keep a sharp eye in particular on the laboratories of synthetic chemists. In fact, hundreds of industries want to help design your future car. Already there is keen competition for a part in its production, and from that competition the car buyer will benefit.

Tire trouble and mechanical failure will be the least of your worries. One company expects tires to be five pounds lighter and stand 20 percent more wear than those of the prewar era. And future cars may be engineered to give good service for decades.



Unobstructed vision for the driver and an almost horizontal steering column will mark the coming cars

In that case, following the lead of the airlines, you'll simply replace each part as it wears out instead of trading the old chariot in on a new one. Ford tri-motored all-metal planes are still carrying passengers in South America after 12,000,000 miles of service. "If we can build planes to last a lifetime, why not cars?" designers are asking.

Push-button control will open doors and windows either electrically or hydraulically. Some manufacturers will try to convince you that windows should never be opened. They would prefer to save weight and get a more streamlined effect through sealed windows set flush with the body. Sooner or later you will get used to the idea, for air conditioning is likely to become general instead of being a de luxe extra as it is now. It will give you all the fresh air you want, and it will keep you warm in winter and cool in summer. Heating will probably be of the radiothermic type so that every part of the car is heated to a predetermined, uniform, and thermostatically controlled degree.

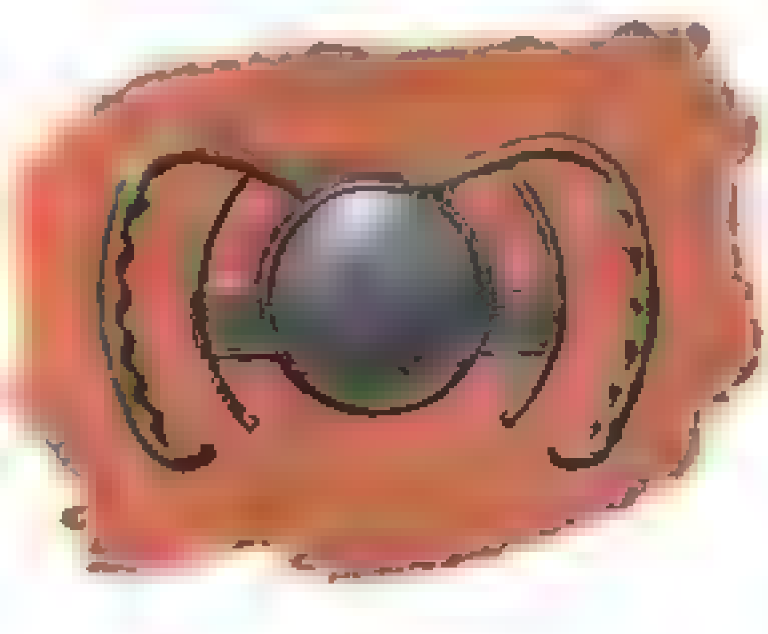
Gone will be rumbles, rattles, and squeaks. Body and frame will be a single unit, with fewer parts to rub against one another. Soundproofing similar to that in airliners will eliminate what noise remains.

A car that does its work with a minimum of help from you will take most of the fatigue and nerve strain out of motoring. That, plus hair-trigger control of speed and direction, simplicity of operation, and unobstructed vision, will remove four chief causes of accidents. Better distribution of weight, a low center of gravity, and improved steering will make it almost impossible to turn over. And as a further safeguard, electronics suggests a number of ingenious warning devices.

There may be some things for which your future automobile may not be suited, such as towing a house trailer. Some designers are not satisfied with just doing away with the frame. To reduce weight further, they want to eliminate tubular bracing from the body, relying for strength on a "stressed skin" alone. While this could be entirely satisfactory, the car might not be capable of towing heavy loads.

The low road clearance of your new car will stop you from driving across uneven fields or over deep-rutted country roads. That is already true of many present models. But if fancy beckons you beyond the point where the pavement ends, you will simply unfold your wings and fly.

Fantastic? Recognizing that the perfect compromise is not yet practical between car and plane, one leading aircraft manufacturer is working on two separate and distinct versions of this idea. First is the *flyable automobile*, a good, serviceable road car, capable of taking off for short hops at low flying speeds. The *roadable airplane*, on the other hand, is to be a good, serviceable plane with a top speed of 150 miles an hour, able to land and roll on to its destination at a road speed of about 30.



The influence of aircraft design is reflected in this new steering wheel

Your future car is being born amidst a great clamor of claims and counterclaims, of wrangling over materials and methods. Your car designer is much like a small boy who gets a peek at his bulging Christmas stocking but must not touch it until Christmas morning. War-born research has

made a wealth of new methods and new materials potentially available, but civilian experimenting can get no priorities.

Any abrupt change in the shape of cars to come will most likely spring, not from the prewar automobile industry, but from new challengers in the field. And new challengers there will be. Henry J. Kaiser, now building a jeep adapted for plane transport, plans to swing into production of civilian cars after the war. Andrew J. Higgins, the New Orleans shipbuilder, has also been prospecting in the field. And at least some of the big airplane manufacturers may enter the automobile market. Whether they can scale their costs down to the levels of the automobile public, however, is a thing to watch. Under wartime conditions, this has been no consideration.

One thing the plane manufacturers argue for is more horsepower per pound of engine weight. They point out that today's aircraft engines deliver nearly one horsepower for every pound of metal in the engine, whereas automobile engines still weigh six to eight pounds per horsepower. On the other hand, automobile engines are built for a little over a dollar per horsepower, while aircraft engines still cost $10 per horsepower.

Bridging the gap between the aircraft and automotive industries are a few companies like the Bendix Aviation Corporation that engineer and build equipment for both. The toughest research jobs often fall to them.

In the sense of giving buyers a lot of car for their money, the major automobile manufacturers have done a splendid job. Mass production and interchangeability of parts have made that job possible. Many parts that go into a Chevrolet are used also in Oldsmobiles, Buicks, and Cadillacs. As a result, General Motors has been able to raise the quality of its lower-priced cars and lower the price of its finest cars. The same applies to Ford with his Fords, Mercuries, and Lincolns, and to Chrysler's Dodges, Plymouths, and Chryslers. Likewise, the Packard and Nash companies get results with mass production. But despite its advantages, the system tends to "freeze" models, and changes come slowly.

The aircraft industry is still highly flexible. Design changes come rapidly and do not wait for a new model year; they are frequently made while a plane is in actual production. Aircraft engineers have learned to make their dies of lead or zinc which can be remelted and redesigned as often as necessary. Whether this can be applied to mass production has yet to be proved.

Actually auto manufacturers have never been slow to try out the latest ideas in motorcar design—perhaps not in the showroom, but certainly on the proving grounds. Probably there is not a major manufacturer who lacks the know-how to produce a rear-engine, teardrop car of radical design.

Believing that Americans are going to be economy-minded after the war, several makers are planning small, inexpensive cars. Willys-Overland has long specialized in the light-car field. Both Ford and General Motors have for years been building small cars in England and on the Continent. These cars are scaled-down versions of American models, weighing a bit over half as much as the models sold here. They are not "midget" cars, but are roomy and comfortable inside. Their tiny, four-cylinder engines give around 30 miles to the gallon of ordinary gasoline. They will do 60 miles an hour and take plenty of punishment. They are easy to park, take less garage space, and are simple to service and keep clean.

But whoever builds the new cars—and the established manufacturers, the airplane makers, and the new challengers are all likely to have a hand—the shape and performance of the cars to come depend ultimately upon what buyers want. If you are thinking about shopping for a new car when production starts again, here are some questions for you to ponder.

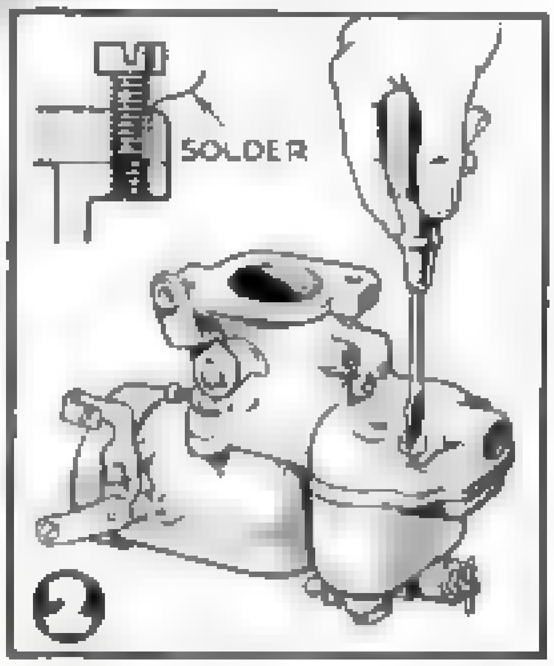
Would you pay more for a car if you were assured it would cost less to run? Is high speed important; or would you sacrifice some speed for the sake of safety and economy? Would it be worth money to you never to have to shift gears? If you knew air conditioning would add to the cost of your car, would you still want it? Do you want your car to be the last word in mechanical perfection; or would you rather have it big and impressive looking? Do you want it to be all automobile; or would you sacrifice some road performance for the sake of being able to take off for a short flight? The designers wish they knew the answers. Ultimately you yourself will decide.

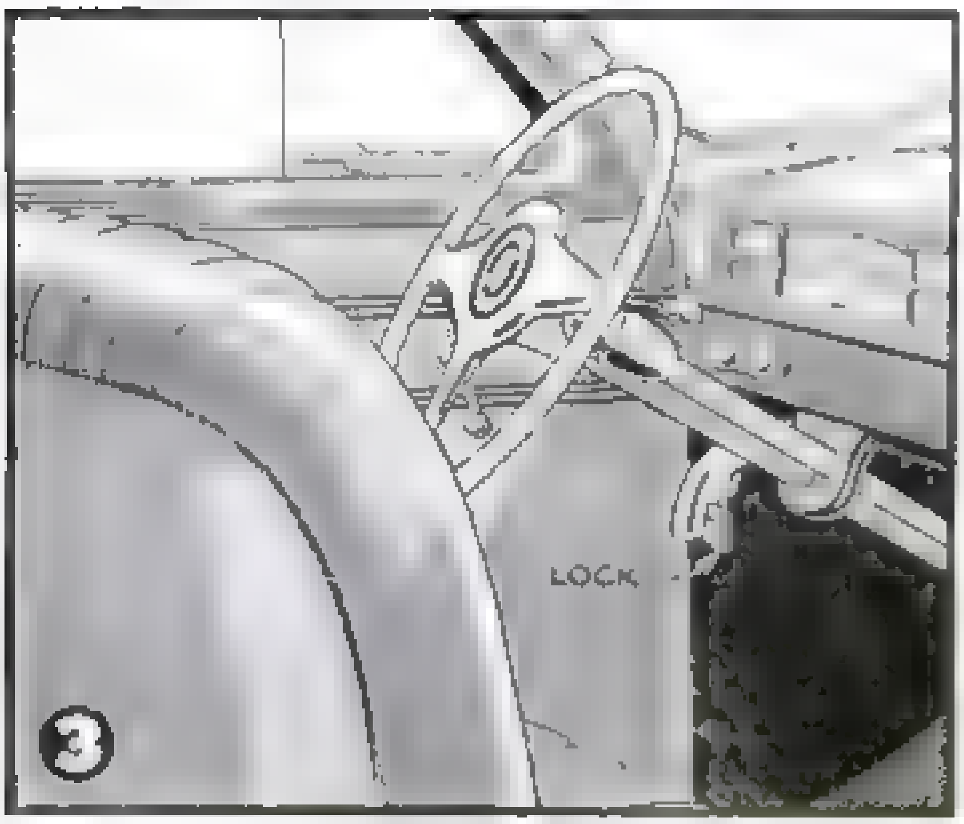
GUS SAYS:

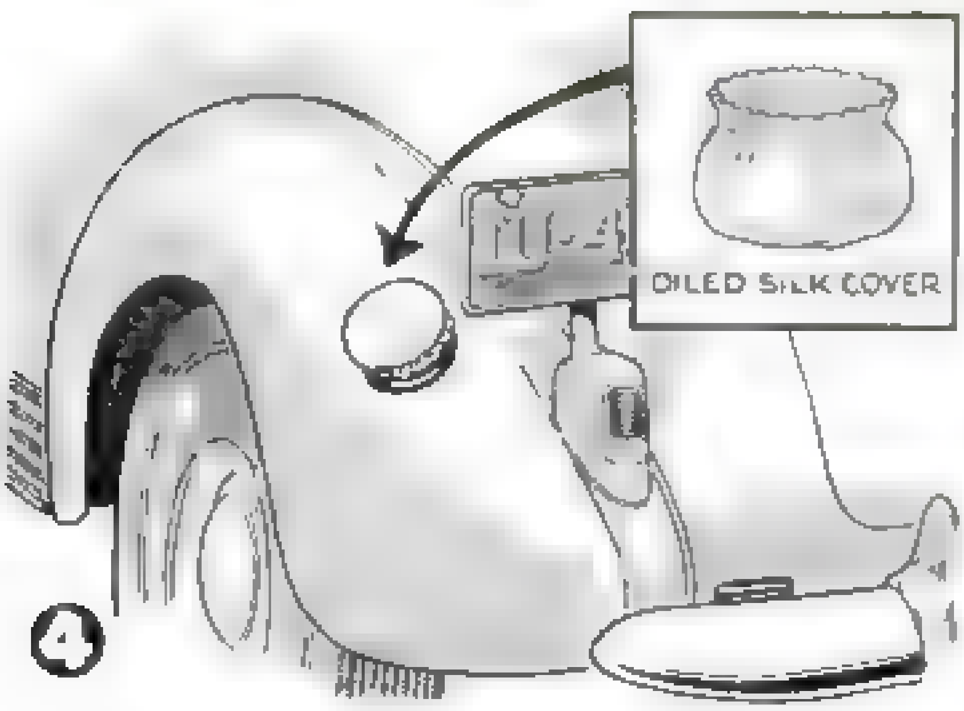
This month, while you've been reading about postwar cars, the Model Garage has been closed so that Joe and I could take a little vacation. Since most of us are going to be considering these new cars when the Axis has been polished off, I'd like to know what you thought of Alfred Sinks' article. Write Gus Wilson, care of P.S.M., and tell me what features you want in the next new car you buy.

USEFUL AUTO HINTS

Drawings by William Patrick.







1 STOPPING YOUR CAR always at a desired point in your garage can be made easier if you suspend a rope from the ceiling and locate it so that it will touch the windshield when you have reached the particular spot at which you wish to bring the car to a halt.—R.E.C.

2 STRIPPED THREADS in light zinc-alloy castings can be repaired with a length of solder. Simply place the solder in the hole and force the bolt in until it takes hold. The solder will act as a filler in which new threads will be cut by the bolt. Such a repair will be permanent if there is not too much strain.—C.R.G.

3 AN EMERGENCY-BRAKE HANDLE held by a padlock cannot be released by children or meddlers. A hole slightly larger than the shackle of the lock should be drilled through the handle at a point not too near the edge. When the lock is snapped in place, the brake handle cannot be compressed sufficiently to release the brake and allow the car to roll.—J.B.

4 GASOLINE-TANK LOCKS frequently become encrusted with ice and are impossible to open as long as they remain frozen. An oiled-silk dish or milk-bottle cover, such as those used in refrigerators, will keep rain and sleet off a lock and guard it against freezing in the coldest weather. Just snap the cover over the neck of the tank, and the lock will stay dry.—W.W.B.


HOME AND WORKSHOP
What Are Your Plans for a Better Kitchen After the War?
CASH PRIZES for Your Answer

$500 Contest
The Kitchen You'd Like in Your Postwar Home

TELL US ABOUT IT IN YOUR OWN WAY AND ENTER OUR $500 PRIZE CONTEST

RULES

Entries in this kitchen-planning contest should consist of (1) a brief description of your design and of any special features or equipment incorporated in it; (2) a floor plan—a rough pencil sketch will do—showing the location of equipment and dimensions of the kitchen; and (3) a statement that the design is original with you. The contest is open to all except architects, those engaged professionally in the design and manufacture of kitchen equipment, employees of POPULAR SCIENCE, and their families. All entries should be mailed, fully prepaid, to the Kitchen Planning Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y. They must be postmarked no later than midnight, January 31, 1944. All will become the property of this magazine, and none can be returned. They should be flat — not rolled. Please write your name and address on each sheet of your entry. The judges will be the editors of POPULAR SCIENCE, assisted by specialists in home economics and kitchen design. The decision of the judges will be final, and in case of ties duplicate prizes will be awarded to the tying contestants.

WHAT do you want in your postwar kitchen besides a full refrigerator, a 10-lb. roast without ration points, and an efficient cook? Barring these suggestions—we thought of them ourselves—POPULAR SCIENCE will pay you for your ideas if you design the ideal American kitchen.

Whether you own your own home or live in a rented house or apartment, you have often wished for changes in your kitchen or new equipment to reduce time or do a better job in the preparation of food. These are the ideas we want—ideas that will reveal what people who use kitchens are looking for in arrangement and equipment. For those judged best, POPULAR SCIENCE offers the following cash awards.

FIRST PRIZE	$250
SECOND PRIZE	125
THIRD PRIZE	50
FOURTH PRIZE	25
FIFTH PRIZE	15
SIXTH PRIZE	10
SEVENTH PRIZE	5
EIGHTH PRIZE	5
NINTH PRIZE	5
TENTH PRIZE	5
ELEVENTH PRIZE	5

This is a contest of ideas, and everyone who enters has an equal chance to win a prize. You do not need to be a draftsman to submit a winning plan, nor do you have to have specialized knowledge of the mechanical parts of kitchen equipment. There is no necessity to dress up your entry with ornamental drawings, to build a model of your kitchen, or to waste time merely to make your entry impressive. What we are asking for is nothing more or less than a clear, common-sense answer to these questions:

1. How would you plan the arrangement of your kitchen—either for the home you now occupy or for a home you would like to build in the future?

2. What pieces of equipment and conveniences would you select—either those now on the market or some others that you would like to see on the market?

You may use your imagination if the designers of kitchen equipment have not yet thought up the equipment to do the jobs you want done, but be plausible, for mechanical and technical possibility is a real limitation. And try to keep the over-all design of your kitchen within moderate bounds.

Planning can be made a fascinating game

for the whole family. The woman who does her own cooking knows just what she wants, but her husband, who putters around to fix a midnight snack for guests or cooks when his wife is away, may have definitely good suggestions. Even the children will have some ideas that may be well worth considering. If you employ a cook, she will have some really professional views, or she may want to enter the contest herself.

Study the equipment catalogues, if you wish; they may have some ideas that will just fit in with what you have in mind. For example, a recent model kitchen shown by one of the manufacturers has such unique features as a transparent-glass oven, built-in range appliances including a waffle iron and a toaster, a transparent-glass refrigerator arranged so that it opens in sections, and a sink operated by pedals on the floor.

While planning, decide whether you wish to use your kitchen for other things besides the preparation of food. Should the refrigerator be a center of attraction in the evening? Would you like to be able to conceal the range and other equipment behind sliding doors so that the kitchen could also be used as a playroom? What jobs are to be done there besides cooking? Do you want a desk for your housekeeping records and files? Would you like to include all or part of your laundry equipment?

These are questions for you yourself to answer. In considering them, give thought to the shape and size of the room you would like, its lighting, and the best arrangement of refrigerator, cabinets, working surfaces, and range. You probably will want to include a number of built-in conveniences, and possibly add some extras like storage bins for your home garden produce, dehydrating and quick-freezing devices, and an electric dishwasher and drier.

To help you in your planning, we have included a blank floor plan on which you may plot your arrangement. If the shape suits you, make tracings, fill in your own dimensions, and work out several trial designs. Then when you have an arrangement that is to your entire satisfaction, you can redraw the plan larger and submit it along with your description. However, you are under no obligation to use the blank, and you may change the shape of the room.

Also in the drawing below are some common architects' symbols. They are shown for your convenience, but it is not necessary for you to employ them. If you do, you are at liberty to change the shape of the range, refrigerator, and other pieces to suit your particular needs.

Sketch any new idea for equipment that isn't on the market, but you need not sketch those pieces that are familiar. Such sketches need not be pieces of art, but you should include a brief description.

Finally, when you have finished, add a paragraph or two to describe the advantages of your entry. Tell the judges why you think you should win. Give them a sufficiently complete description so that they will know just what your kitchen would be like.

Architects' symbols and a floor plan that may help you in designing your postwar-kitchen contest entry

TURNINGS SET OFF THIS DISTINCTIVE

Serving Tray

By FRANKLIN H. GOTTSHALL

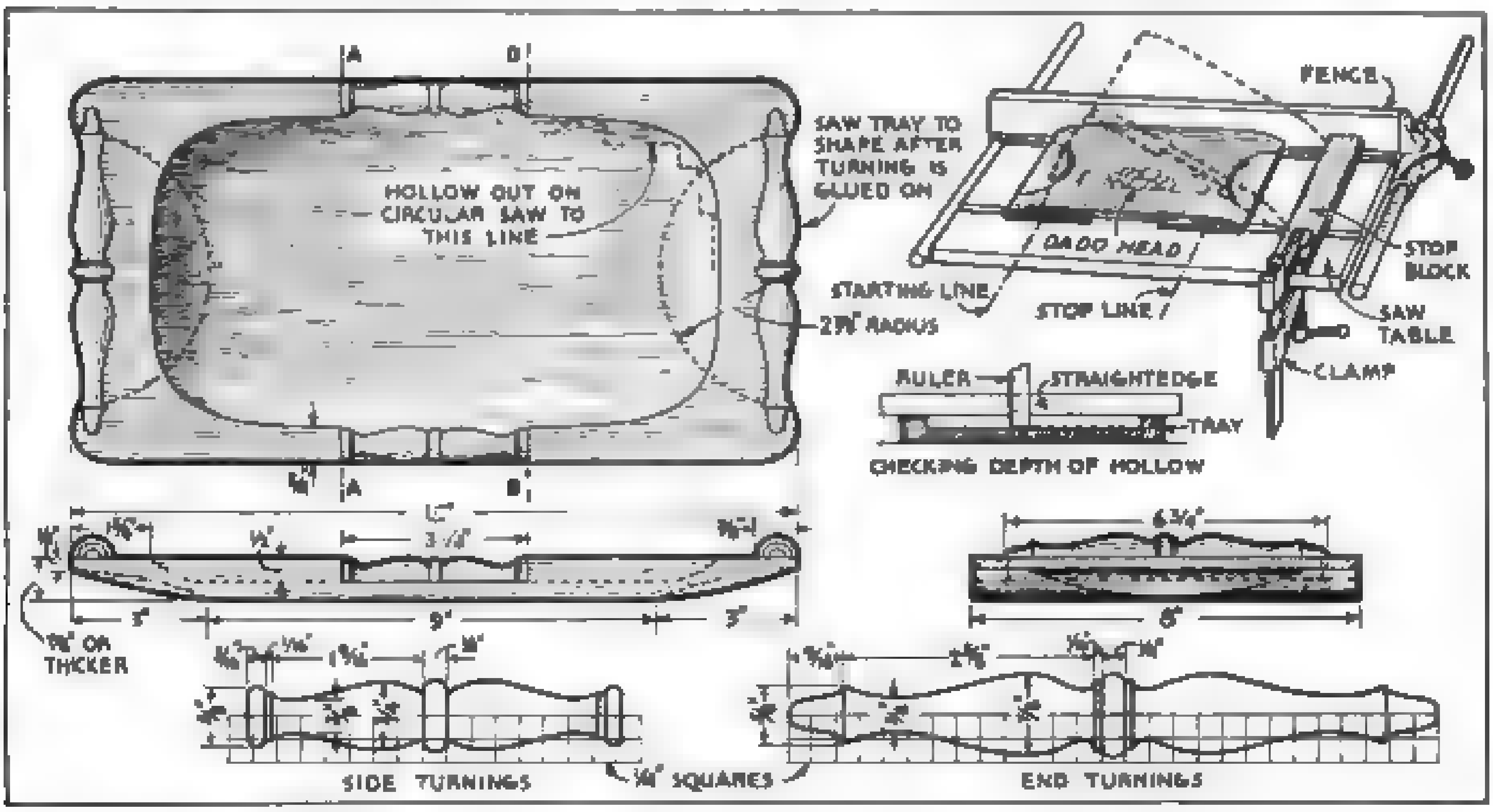
WASTE material, bandsawed from the splat of a chair, suggested the design for this unusual tray, which will be a unique and useful gift for any homemaker. Mahogany, walnut, or poplar, 1" by 8" by 15", are all good materials for this project.

The first step is to finish the bottom of the tray, which should be flat except for 3" at each end, where it is given a slight curve upward. These curves can be planed to the contour shown in the drawing

Several wood-carving gouges will be useful in hollowing out the handles as well as for trimming the edges of the scooped-out part once the rough work has been completed. Should a circular saw with a dado head be unavailable, gouges must be used.

If a saw table is available, the first part of the dadoing should be crosswise. This operation is not difficult, but when cutting lengthwise more care must be exercised. For then, as indicated in the drawing, the cuts at the side of the tray cannot be carried as far as those in the center. Thus the starting line and the stop line will have to be shifted to new positions to make the shorter cuts. The middle cuts should be made first, and the shorter cuts should be done alternately from each side.

The ends of the tray are not bandsawed until after the split turnings have been glued in position. These turnings are made by gluing a piece of heavy paper between two strips of wood. After the turning, the two pieces can be separated with a chisel. Several coats of floor varnish, with a pumice-stone and oil rub for the final coat, will give the tray a good finish.



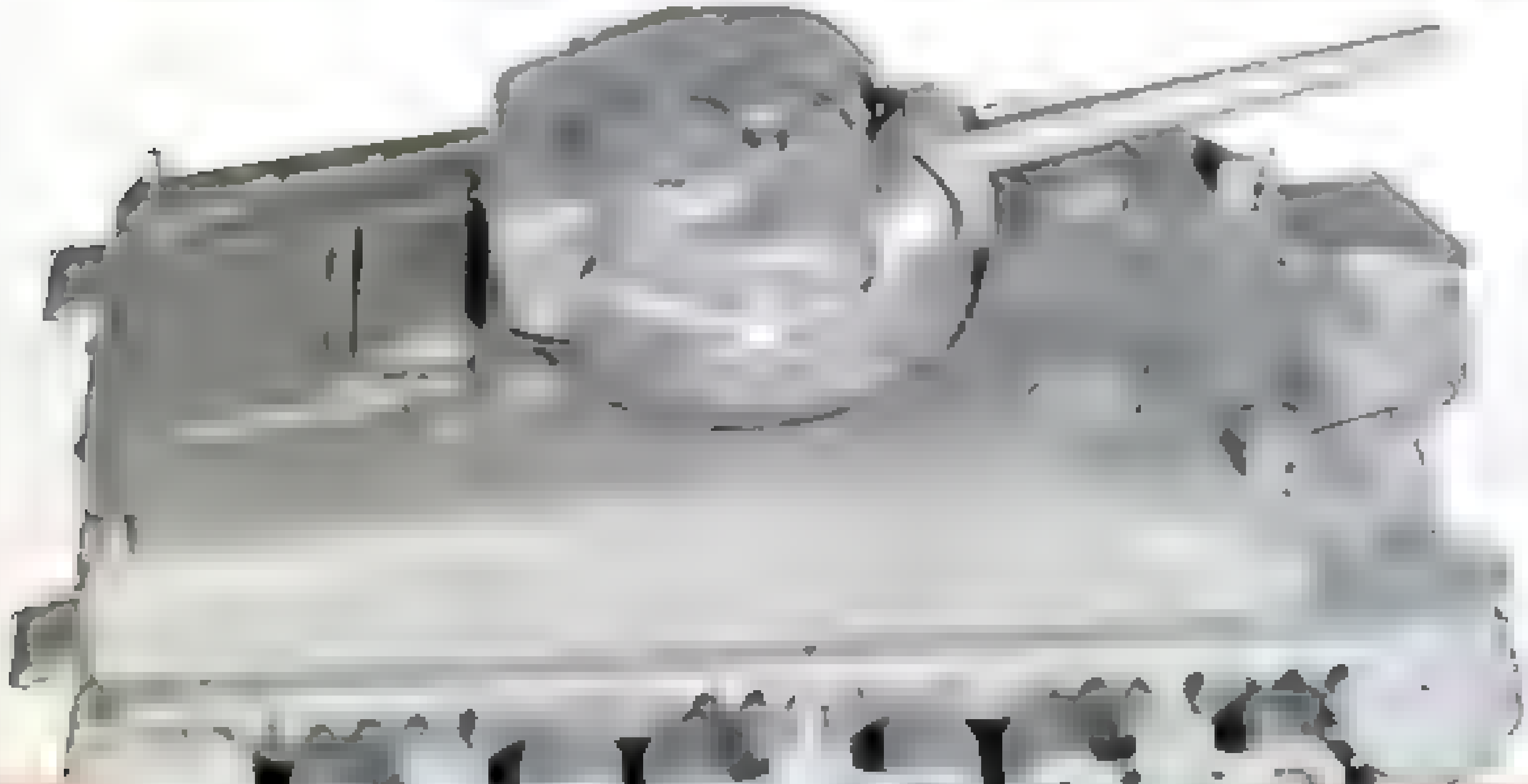
IT MADE HISTORY IN AFRICA

M-4

REALISTICALLY MODELED

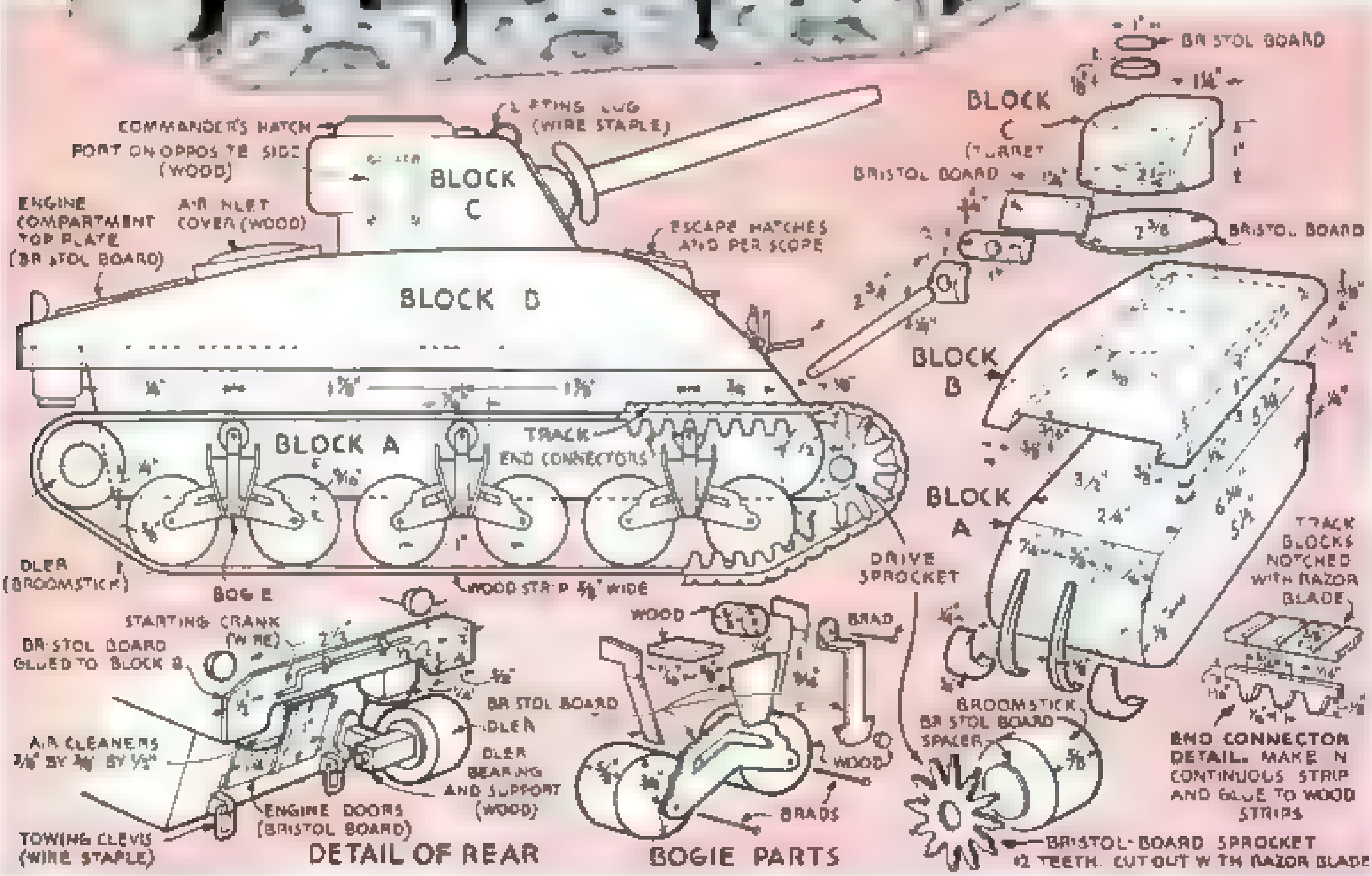
THE U. S. M-4 medium tank, which has outfought far heavier German tanks, is the prototype for this attractive model, scaled 1/2" to 1'. Three blocks of white pine, sawed to approximate shape and formed with a plane, file, and sandpaper, comprise the main parts.

Assemble the bogies, idlers, and drive sprockets, which are made of two-ply Bristol board and dowels, and glue them in place on block *A*, which is 1 1/8" high. The track, made of 1/16" pebble board, is notched to simulate individual blocks and reinforced with wood strips steamed to fit the idlers and driving sprockets. The wood strips also support Bristol-board end connectors.



In the test of battle, this U. S. tank scored heavily. Model makers won't find it hard to build in miniature

Three pine blocks are sufficient for the turret, armor and hull. Bristol board dowels and scrap wood will do for the remainder



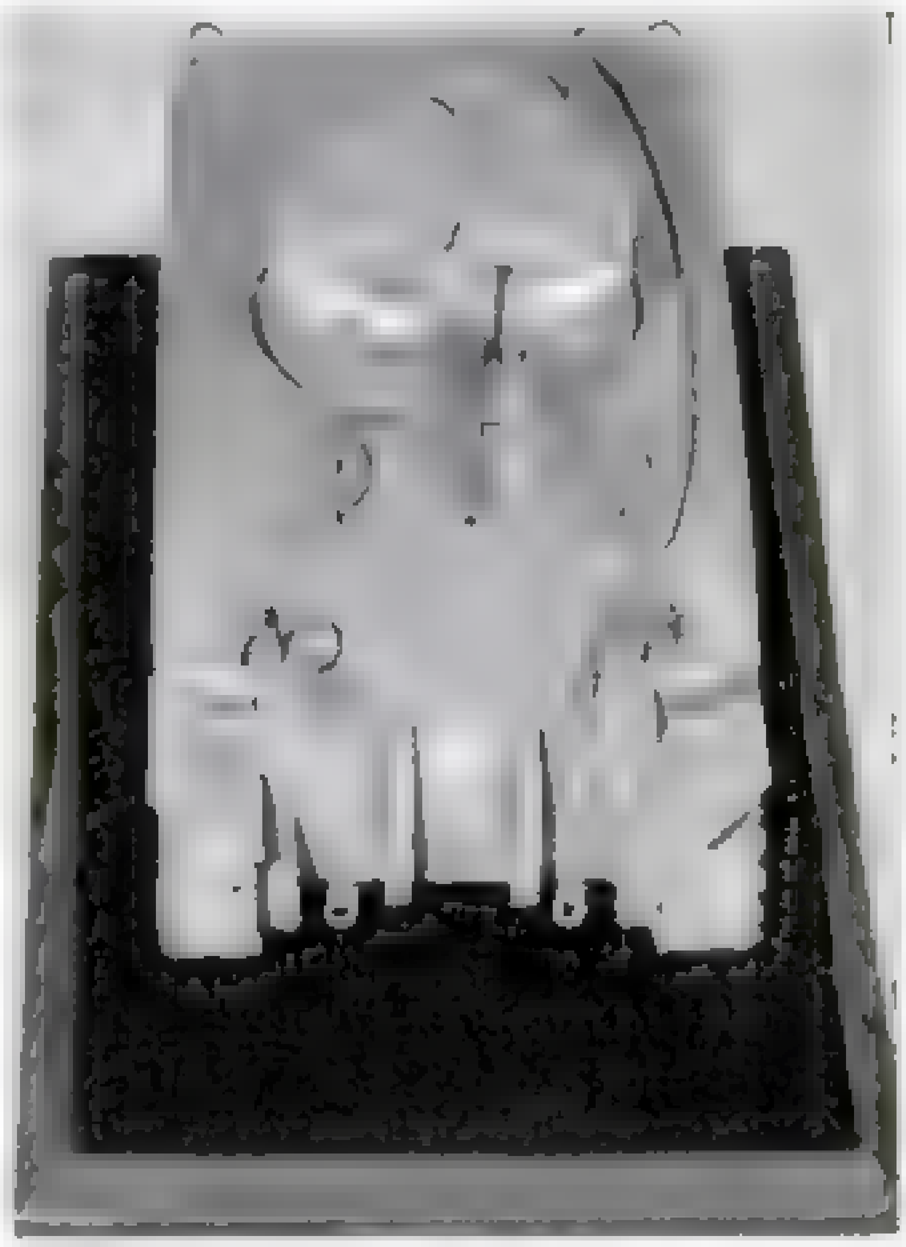
Medium Tank

IN WOOD AND CARDBOARD FOR YOUR MANTEL

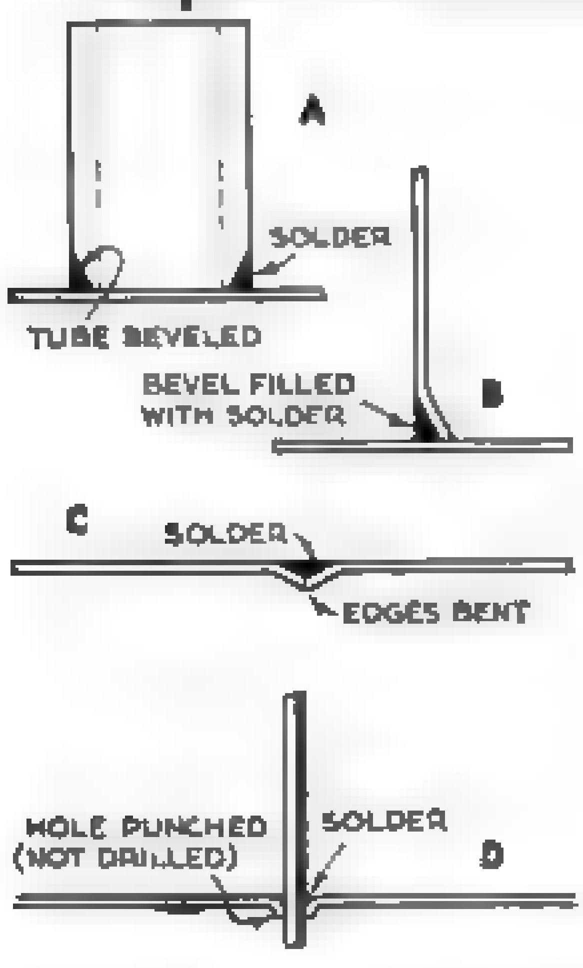
Escape hatches, lamps, and other fittings are formed and glued to block *B* as indicated in the photographs. Blocks *A* and *B* are then glued together, with the front edges lined up to produce a continuous curved surface. Next, model the 75-mm. gun, commander's hatch, and lifting lugs, and glue them on block *C*. The gun shield, whittled from wood, is slipped over the gun and glued into place, while a circular piece of Bristol board, representing the turret ball-bearing raceway, is glued to the base of the turret before the assembly is attached to block *B*.

Mudguards, air filters, and the flanges and gear housings on the front of the hull come next. The latter can be shaped for a snug fit by holding a piece of fine sandpaper, facing out, against the front contour of block *A* and sliding the pieces back and forth over it.

The model should next be sanded thoroughly and sprayed with white shellac. Then mix 1 part apple-green paint with 2 parts neutral gray and add sufficient turpentine to permit easy spraying. Spray the final coat with the blower about 18" away. The paint will then settle in tiny droplets, giving a steel-casting effect.—FRED H. COLE.



Simple Tricks Assure Strong Joints in Model Making



SOLDERED joints sometimes present a special problem in model making, because so much of the solder is usually filed away in an effort to secure the desired neatness that the joint is thereby weakened. A simple method of making soldered joints that are both inconspicuous and strong is to file two bevels on the pieces to be joined, or to bend them so that they form two bevels when butted together. It is then possible to file the joint flush on the side where appearance counts and still have plenty of solder remain. Drawing *A* suggests how a tube can be soldered in this manner to a flat surface, while *B* indicates the way two flat surfaces can be joined at right angles. When it is necessary to solder two flat sheets together at the ends, the method shown at *C* will give excellent results. To solder a wire rod in a piece of thin metal, as in *D*, punch a hole—do not drill it—in the sheet and fill the depressed edges of the hole with solder.—M. CYLE SMOCK, JR.

EARLY AMERICAN

Windsor Table

IS REPLICA OF RARE MUSEUM PIECE

By Frank Hegemeyer

THIS Windsor table, copied from a rare museum piece, will make a charming addition to your living room and will prove extremely useful as an occasional table. Like all Windsor furniture, the piece shown here retains the good looks and sturdiness that made its namesake popular. It is a direct descendant of the English Windsor chairs that first made their appearance in this country about 1700 and are still being made, valued today not only as reproductions but also for service. The raised edge of the top is a feature borrowed by the Windsor style from a dish-top candle stand of around 1800.

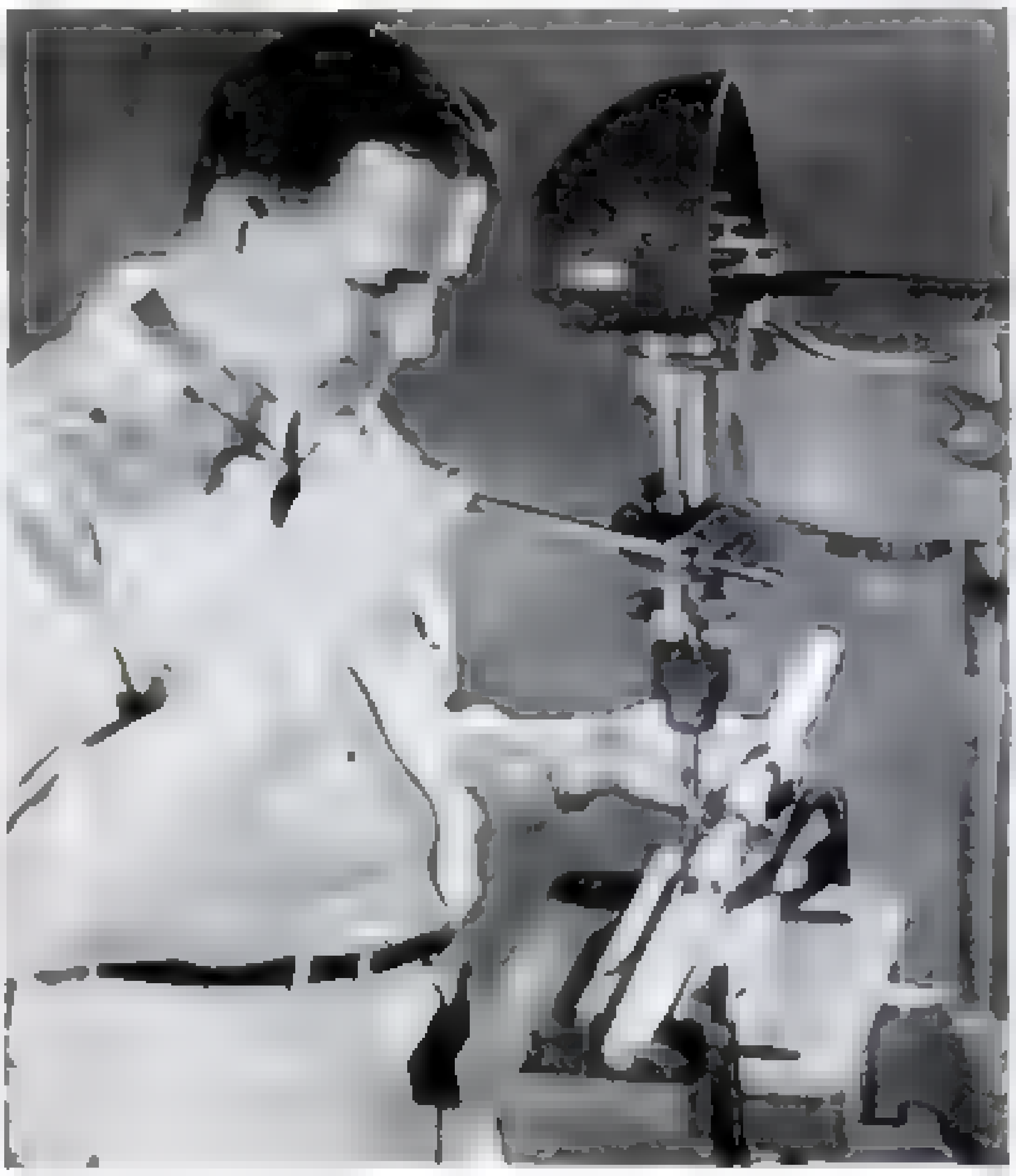
Any fine cabinet wood is satisfactory for the table, and your choice will probably be governed by the wood of the other furniture in the room in which it will be used. So little stock is required for the construction that the cost will be nominal regardless of the wood selected. With this in view, it might be a good idea to make a pair of the tables to support lamps at each end of a couch or sofa.

Probably the most tricky part in the construction is the boring of the holes for the three stretchers. As a guide in locating them on the legs, make a paper template as shown in Fig. 3 in the drawing on the facing page. A 6" rule is laid diagonally above the paper, and parallel lines are projected from its inch markings to the paper. Any two adjacent lines may be used in spotting the dots that will serve as guides for the stretcher holes. The dot to the right is placed 2" below the top edge of the template, and the other is spotted ⅝" further down, as shown.

In transferring these dots to the table

Holes in the legs for the three stretchers are marked off with an awl from a template made as shown in a drawing on the facing page. Note that they are not on a level

Then they are bored on the drill press while the leg rests in a V-block clamped to the drill-press table, which is tilted 6 deg. for the upper hole and 14 deg. for the lower so the stretchers will fit properly

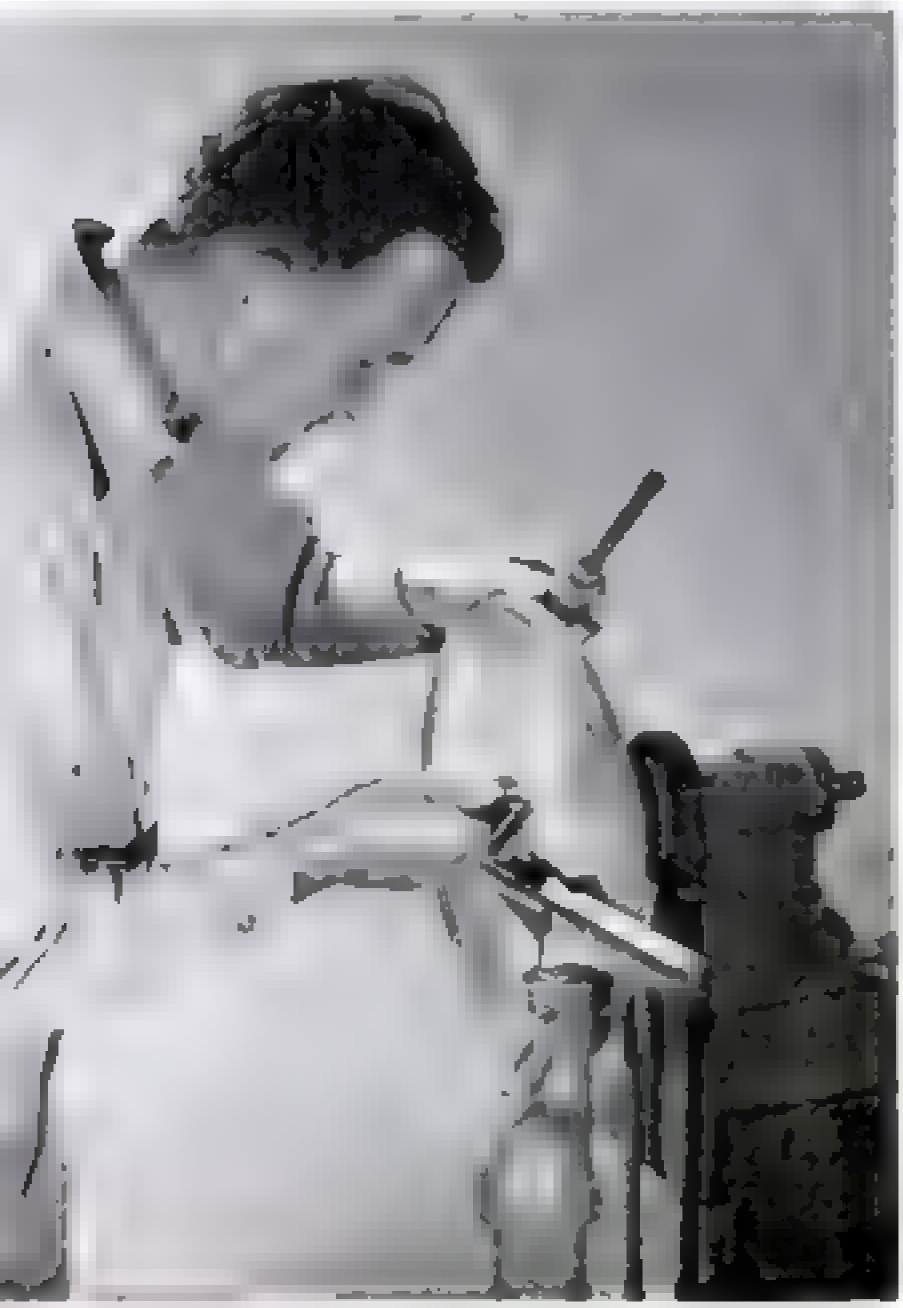


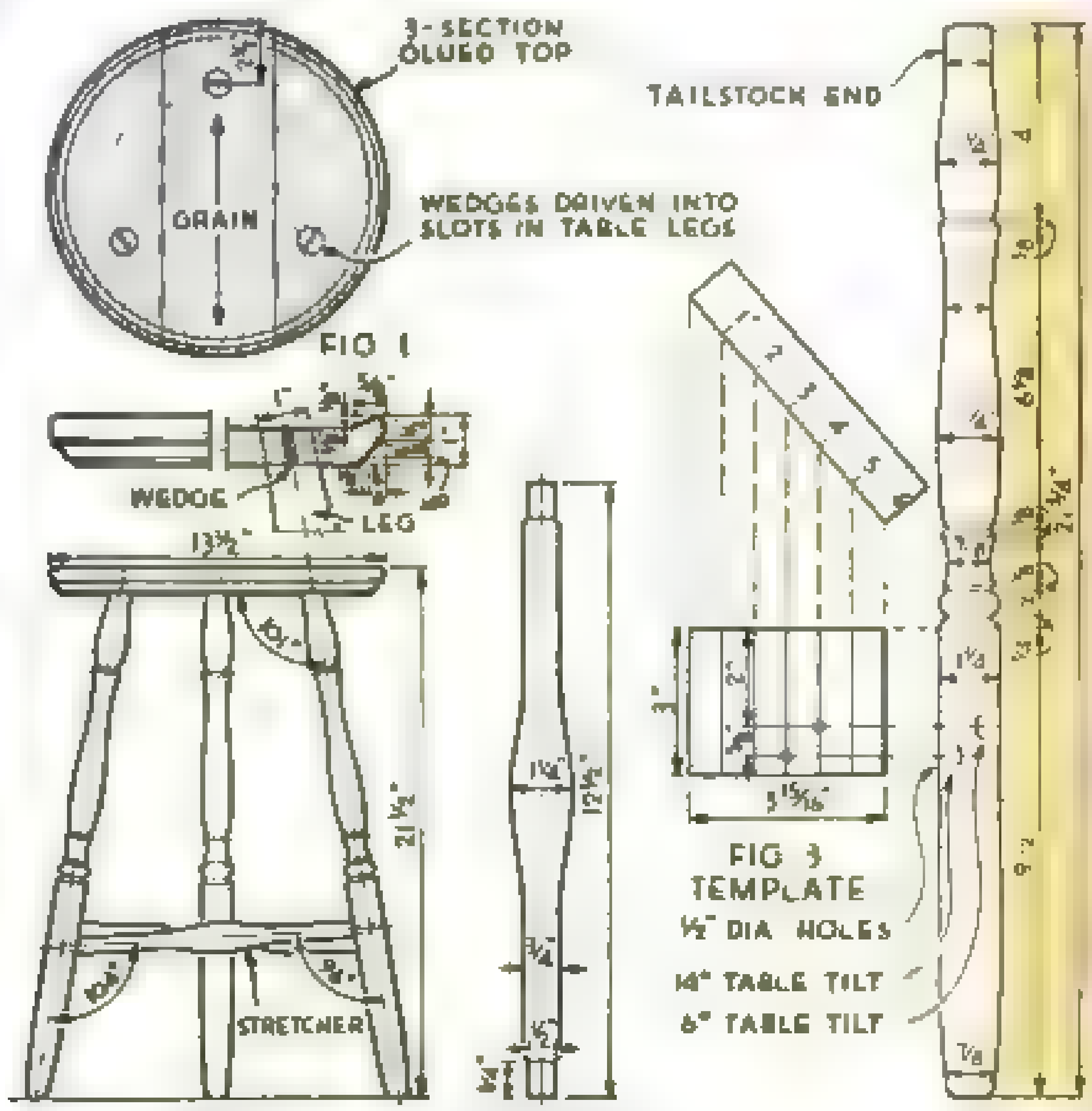
legs, wrap the template around a leg with the top edge even with the bottom of the ¼" bevel, which is the lowest one on the turning. Pierce through the paper at the dots with an awl or a sharp nail. The holes are not bored vertically into the legs, but at a slight angle—6 deg. off the vertical for the upper hole and 14 deg. for the lower. A V-block clamped to the drill press will be helpful. If the boring is done by hand, it may be easier to follow the angles given in Fig. 2 of the drawing, which will produce the same results. This is also true of the leg holes bored in the table top.

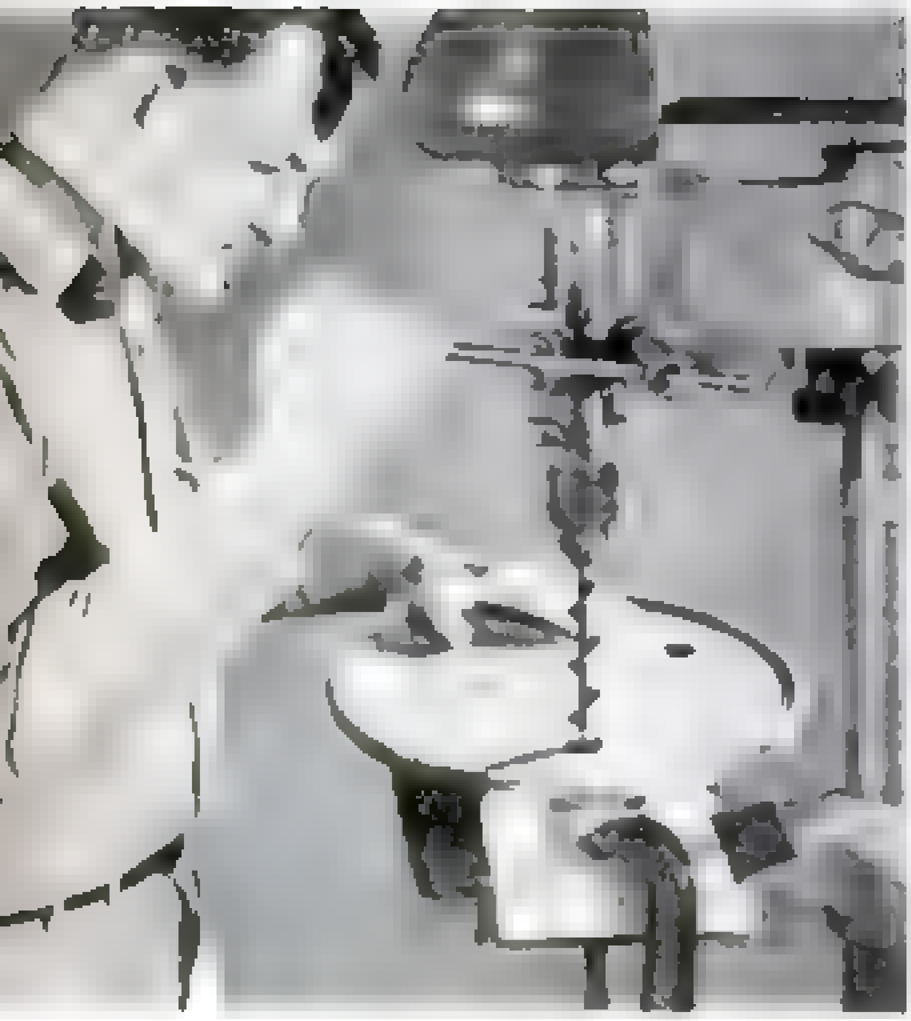
Make up the top of three glued-up boards to minimize warping; then turn it on the faceplate to the dimensions given in Figs. 1 and 2. To locate the leg holes, mark a triangle on the top with the points 2½" from the outer edge, having one of the points on the center line of the middle board. Bore holes through from the top at the marked points with the drill-press table tilted at 11 deg. Use a jig consisting of two stop blocks nailed to a board, as shown in

Placed beside an armchair, or used in a pair at the ends of a couch or sofa, this table will add charm to your living room. All dimensions for turning its three legs, three stretchers, and top are given in the drawing below

Three boards are glued up for the top and the piece is turned on the faceplate at slow speed. This may be increased to about 1,200 r.p.m. for the final truing







After laying out the holes for the legs, place the table top against stop blocks nailed to a board, which is then clamped to the drill-press table. Drill at an angle. During a trial assembly, mark cut-off lines for the legs and slots for wedges in the ends. After final assembly, drive the wedges in and sand them level with the legs

the photo appearing directly above.

Assemble the three legs and stretchers temporarily, and insert the legs in the holes in the table top so that cut-off lines and the slots for the end wedges can be marked off. The table is then dismantled, and the waste portion is removed from the legs and the slots are cut. Reassemble the piece with glue at all joints; then drive the tight-fitting wedges solidly into the slots. The legs and wedges should protrude slightly to allow for sanding them flush with the top.

What finish to apply will depend on the material. The final effect should be a dull sheen obtained by rubbing the last finishing coat well.

CUTTING RAFTERS BY PATTERN

[*SHIPSHAPE HOME*]

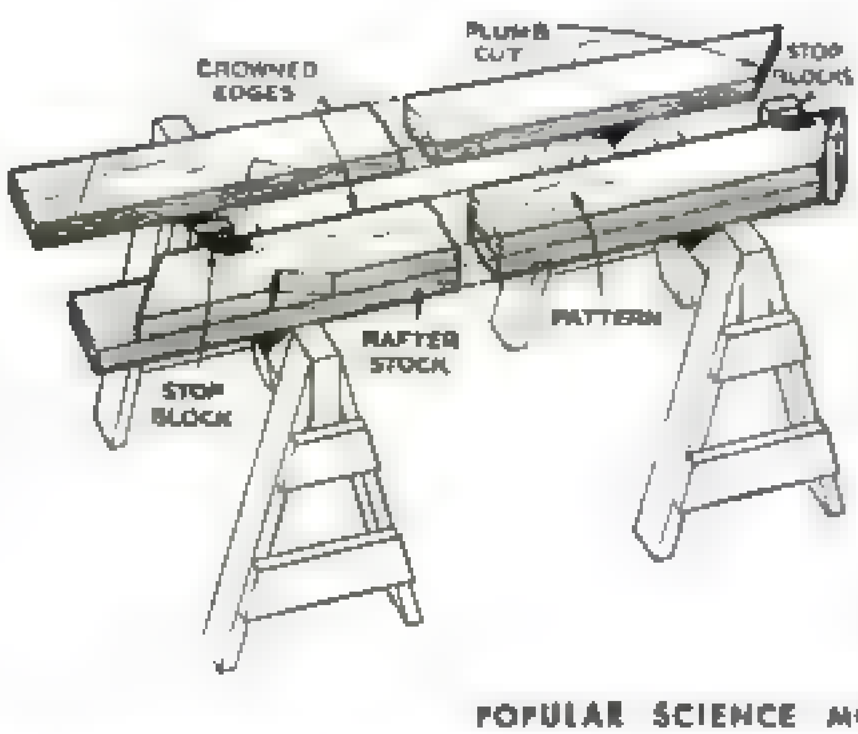
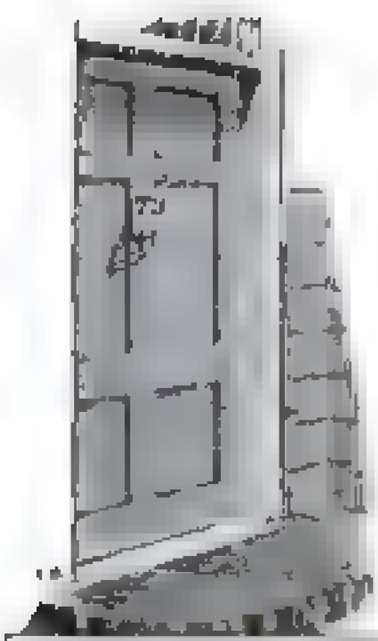


Figure the roof pitch and length; then cut one rafter for a pattern, being sure the plumb cut at the ridge, the notch that fits over the edge of the plate, and the exposed rafter end are true in relation to the angle of the slope. Use this one rafter pattern for marking all other rafters. Nail three stop blocks to it, as shown in the sketch, and mark off the end cuts and notch on several pieces of rafter stock at one time. Use a crosscut saw, or power saw, for all cuts excepting the top cut of the notch, where a ripsaw may be easier to use.

Always sight along the edges of an uncut rafter and place the crown upward, as this tends to make an unwavy finished roof after the load of roof boards and shingles or roofing materials is applied.

POPULAR SCIENCE MONTHLY SHOP DATA

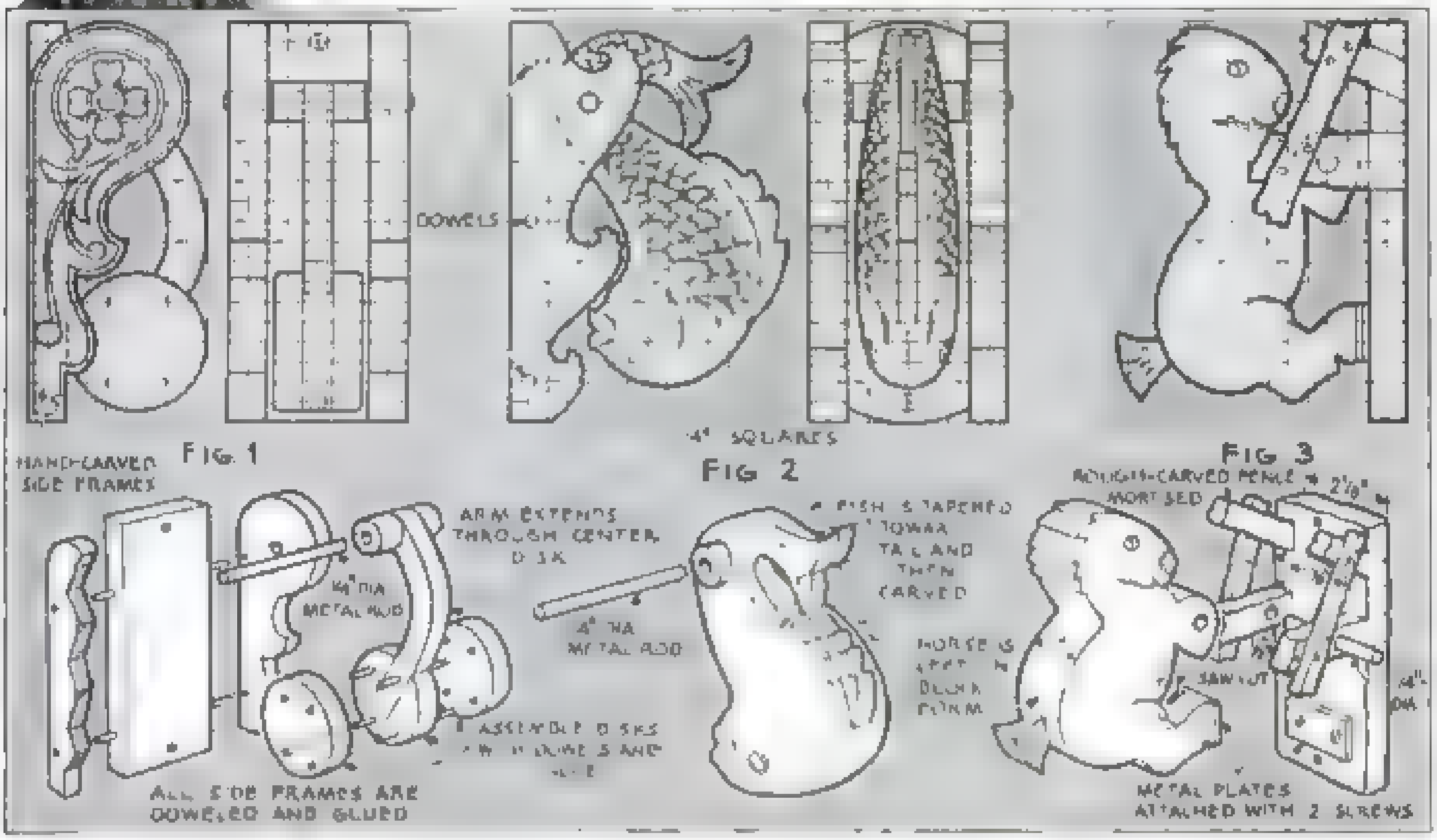


Hardwood Knockers Make Artistic Novelties

HARDWOOD door knockers built according to the imaginative designs below will grace the door of almost any home, and they can be made to fit the individuality of your own house. The more conventional appeal of Fig. 1 is obtained by hand-carved side frames from which a modest knocker composed of an arm and three disks swings on a metal rod. Spacers on the rod keep the knocker from striking the sides.

The creature of the deep in Fig. 2 is sawed in profile from 1¼" stock, then tapered toward the tail. The side frames suggest waves. The iron-shod heels of the horse strike against a metal plate.

Color can be used on the knockers, but a natural finish protected with outdoor spar varnish will also please.—H. S.



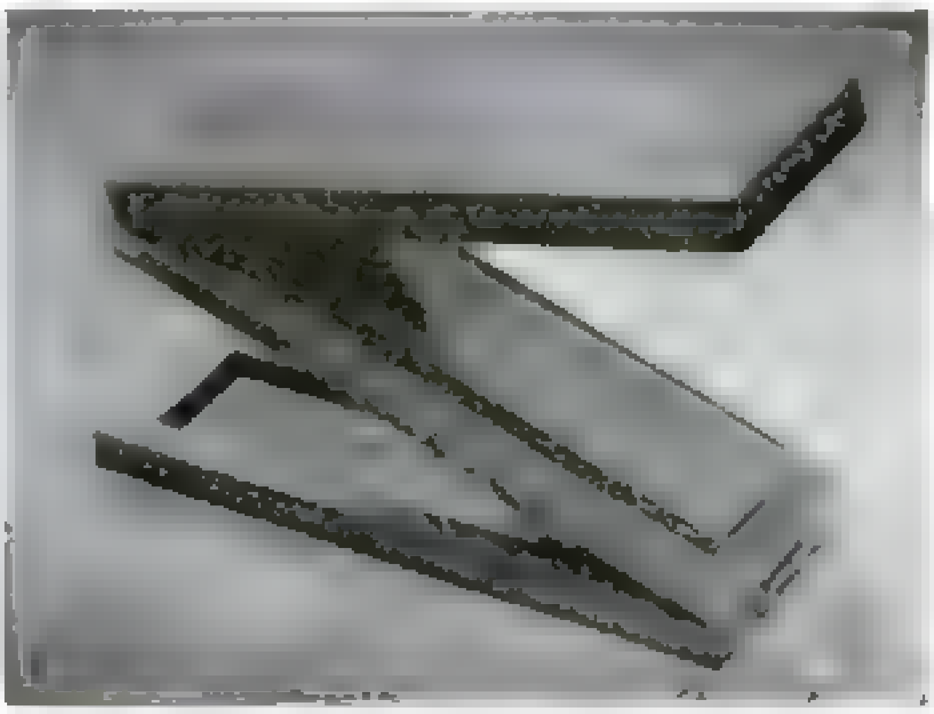
Double-Hinged Case Protects Combination Sharpening Stone

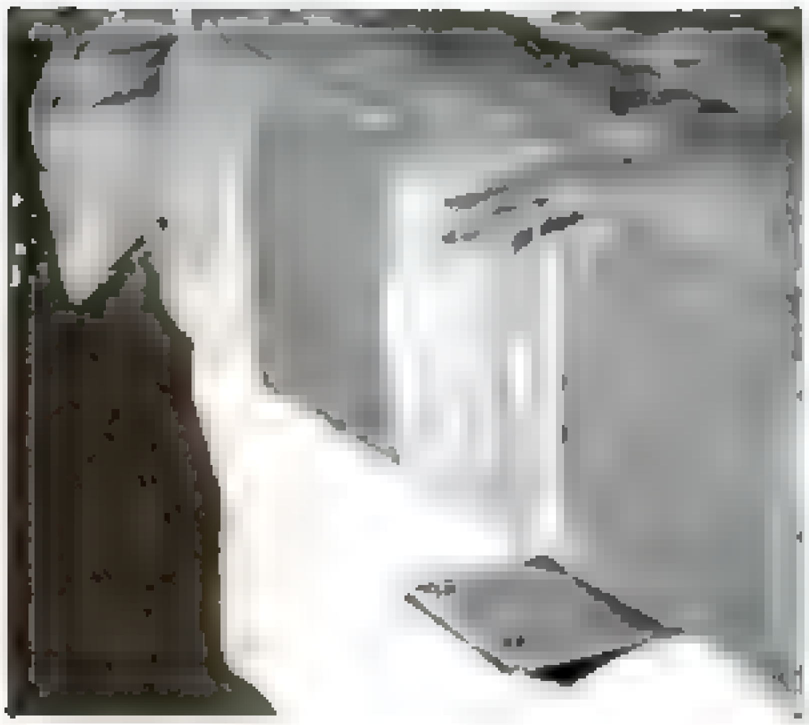
GUARDING your sharpening stone from rough contact with tools in your kit and on your bench is the best way to increase its useful life. This simple wooden case provides protection by means of hinged covers for both the coarse and fine-grit faces.

Pine is satisfactory wood for the case, although any scraps on hand may be used. Make the frame from ⅝" thick stock about 1¼" wider and 1¼" longer than the stone, jigsawing the center for a snug fit with the stone. This fit should be such that the stone will not slip out and suffer a possible fracture if the case is picked up with both of the hinged covers open. When the stone is in use, however, one of the covers will always be closed to serve as a base.

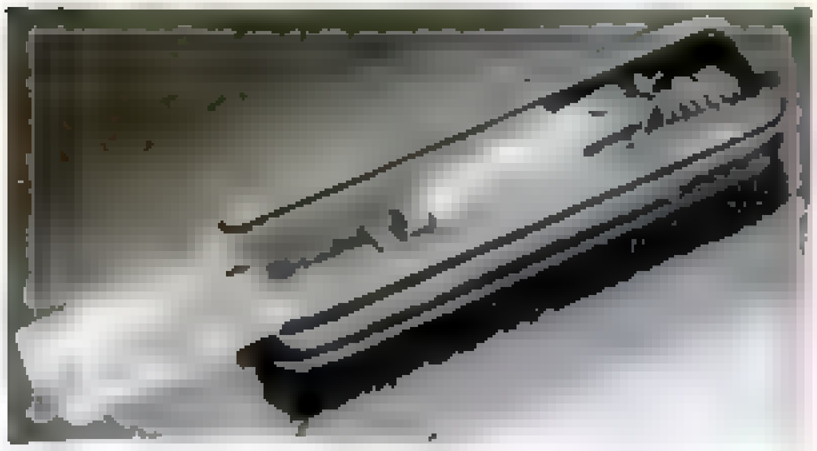
To prevent warping, dado the ends of the frame across the grain to a depth of about ½" and glue in splines. These may protrude slightly for a stepped effect.

Both covers are from ¾" stock routed on the drill press or chiseled to the depth required by the stone. Hinge them at opposite ends as shown.—WILLIAM FREEMAN.



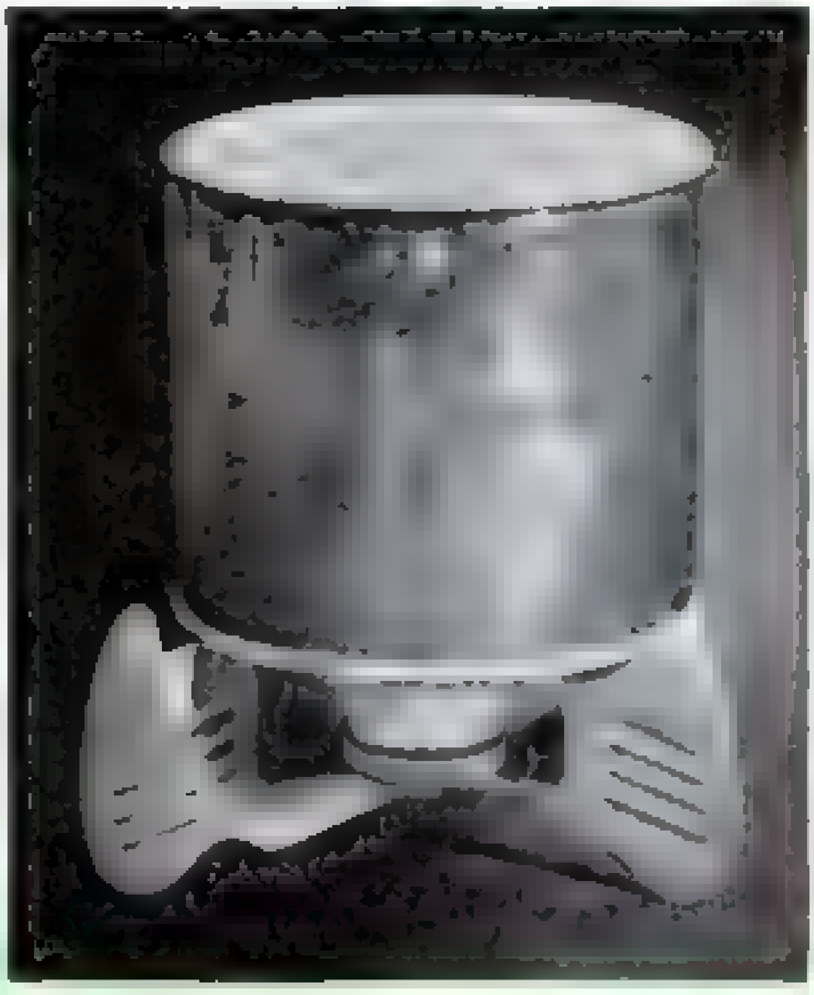


COMFORTERS STAY ON THE BED no matter how much you toss, when they are anchored as the one shown above. A cloth-covered board is slipped between the mattress and springs, and attached clips hold down the comforter



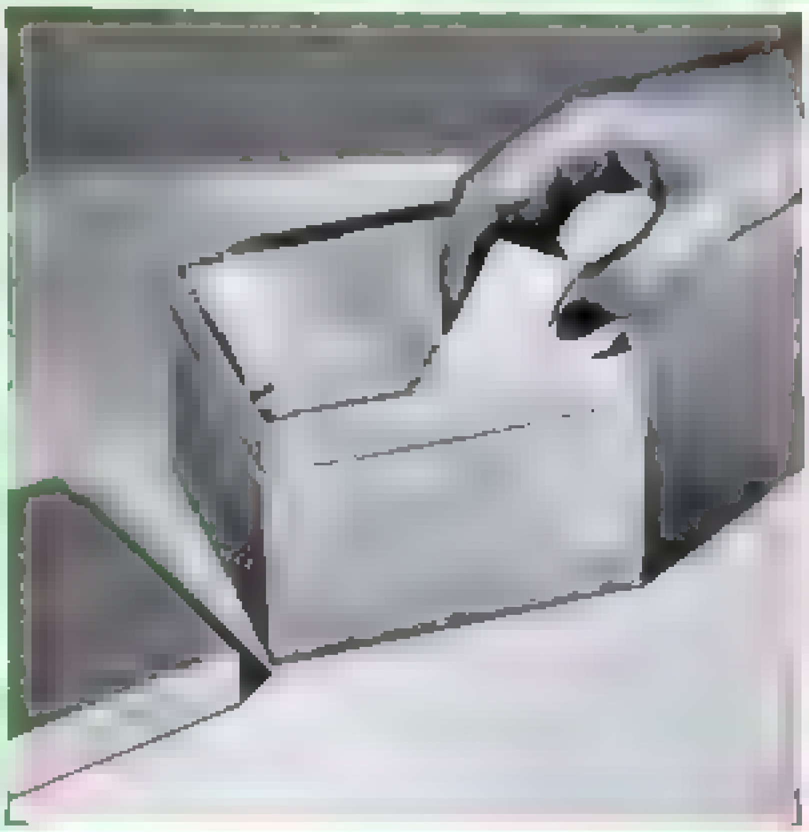
TOILET ARTICLES, such as tooth paste, comb, and toothbrush, find a handy repository in the hollow back of this clothesbrush, which is fitted with a sliding cover. The slide is made of transparent acetate that allows a clear view of the contents in the cavity below. A knob at one end furnishes a grip

PLASTIC TUBES like the one being placed in this refrigerator will keep foods from drying out. The tubes are a foot long and contain water that evaporates very slowly. They are transparent and odorless, and are also useful in bread boxes, where they will help baked goods to retain their freshness



ON A MINIATURE STOVE such as this one, hot food can be prepared under almost any circumstance or emergency. The stove folds into a pocket-size kit that includes a can opener and tablets of a nonpoisonous fuel. Each tablet will burn for several minutes, long enough to heat ½ lb. of solid food

SOAP POWDER in individual packages, put up in boxes of 40, as shown below, will take out ink stains or mildew from such fragile fabrics as lace spreads and window curtains without injuring them. Powerful but mild, the soap will remove stains without rubbing if one packet is used to a bowlful of water



AIDS TO WARTIME

Housekeeping

BAKING SHELLS of heat-resisting glass are being offered in a style designed to imitate the natural shells, or coquilles, which have been popularized by French chefs. The new molds are realistically fluted, making attractive shells for serving flaked crab meat and other seafood. They may be placed in a hot oven for the quick browning of any creamed fish.

ONE CUP OF COFFEE can be made just the way you like it with this small glass dripper that fits right on top of the cup itself. The coffee is strained in seeping around the edges of a cloth drawn tightly about a removable glass disk by means of a puckering string. The device cleans easily

GLASS FRUIT-JAR FILLERS, sparkling and easy to clean, fit snugly into the top of any standard jar. About 4" across the top, the cup-shaped fillers have a handle at one side that makes them a convenient funnel for the pouring of any hot liquid. They stand upright when set down on a flat surface

WOODEN CANNING TONGS serve as well as metal tongs when used for lifting hot jars from a kettle of boiling water. Those in the photo are hinged at one end, while the open ends are curved to grasp the top of a jar securely. The tongs are also handy for grasping grilled potatoes or frankfurters

STURDY TOYS FOR YOUNG

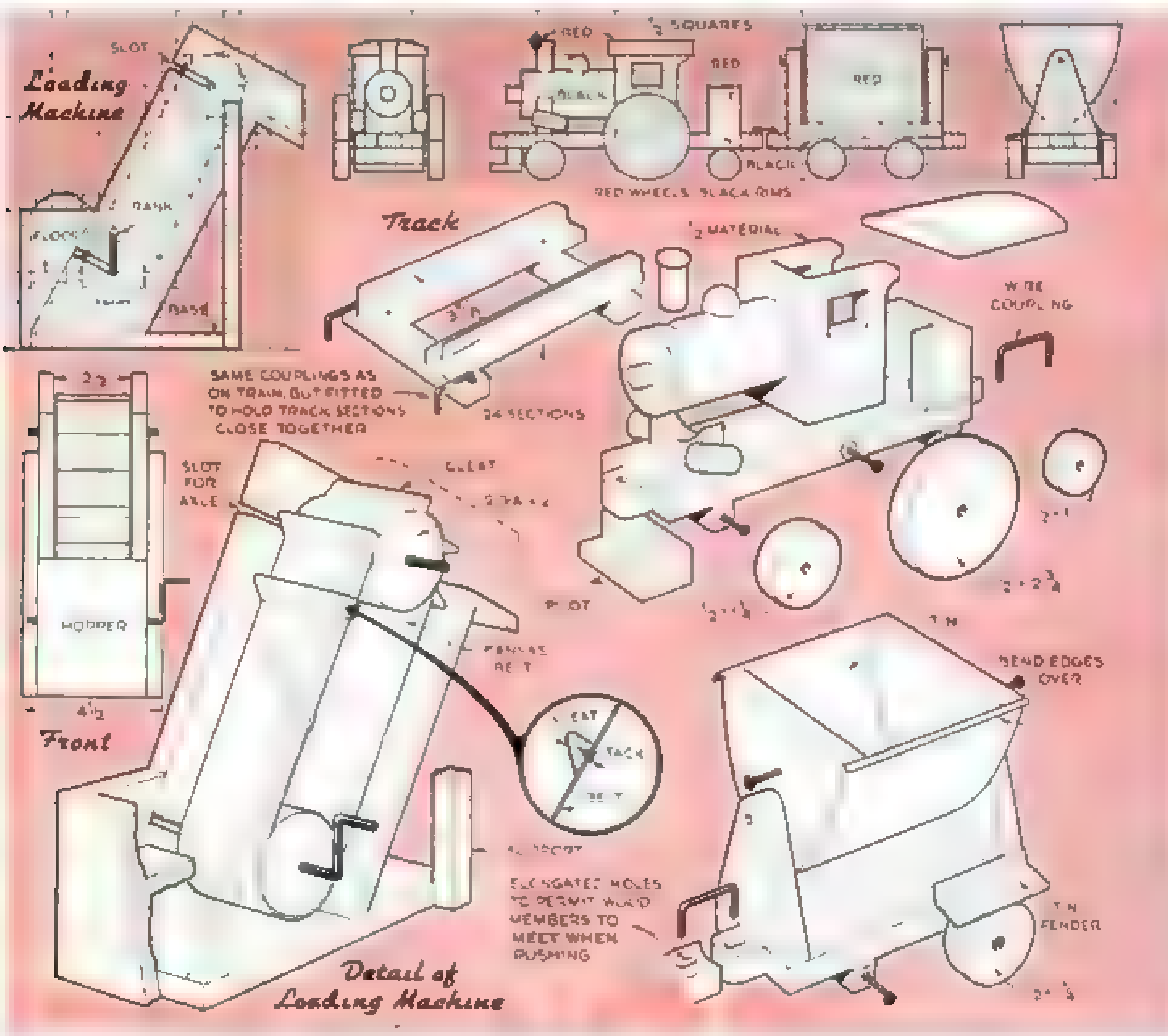
Sand-Pile Engineers

By

HI SIBLEY

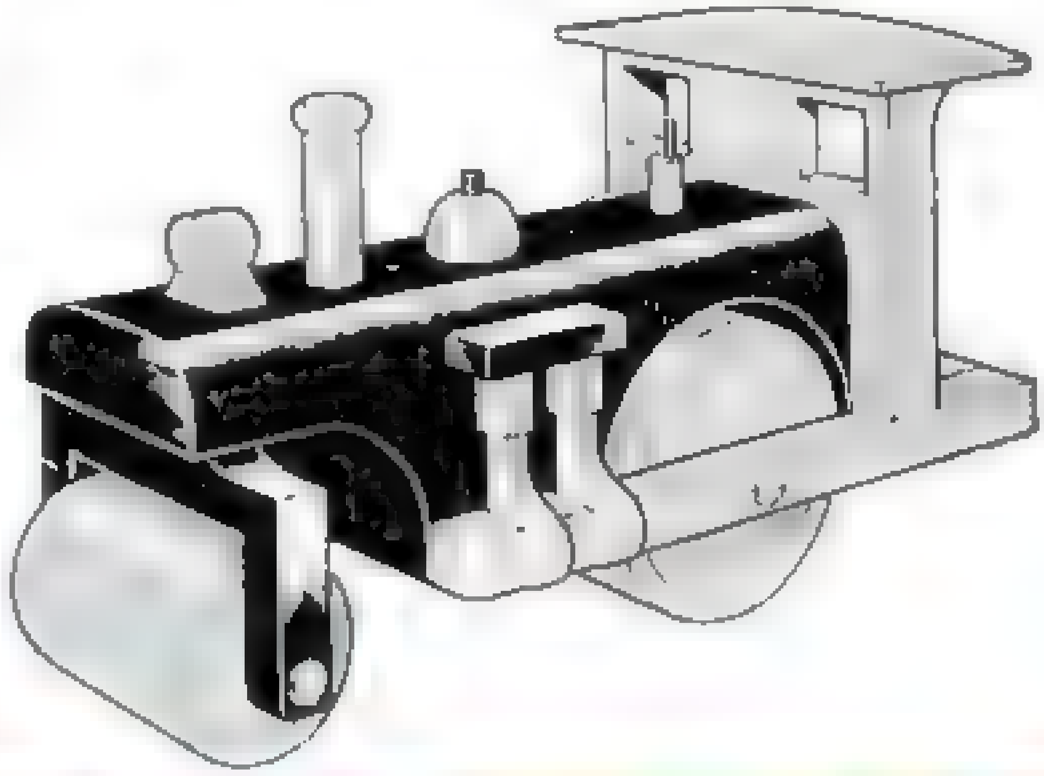
CONSTRUCTION TRAIN. Children will have fun building roads and harbor improvements with this sturdy little construction train. The train runs on a wooden track made in sections that couple together, and the hopper cars, after being filled by a loading machine, can be pushed to their destination and dumped of their cargo of sand. The boiler of the locomotive is solid wood, as are the smokestack, steam dome, and cylinders, and ½" stock is used elsewhere. The hopper cars have pivoted bins that can be dumped to either side, and their tin fenders keep sand off the track. Wire couplings are set in slots so that the convex-concave bumpers fit neatly and do not tend to shove the cars askew. Wheels can be cut from curtain poles and rolling pins if you have no lathe.

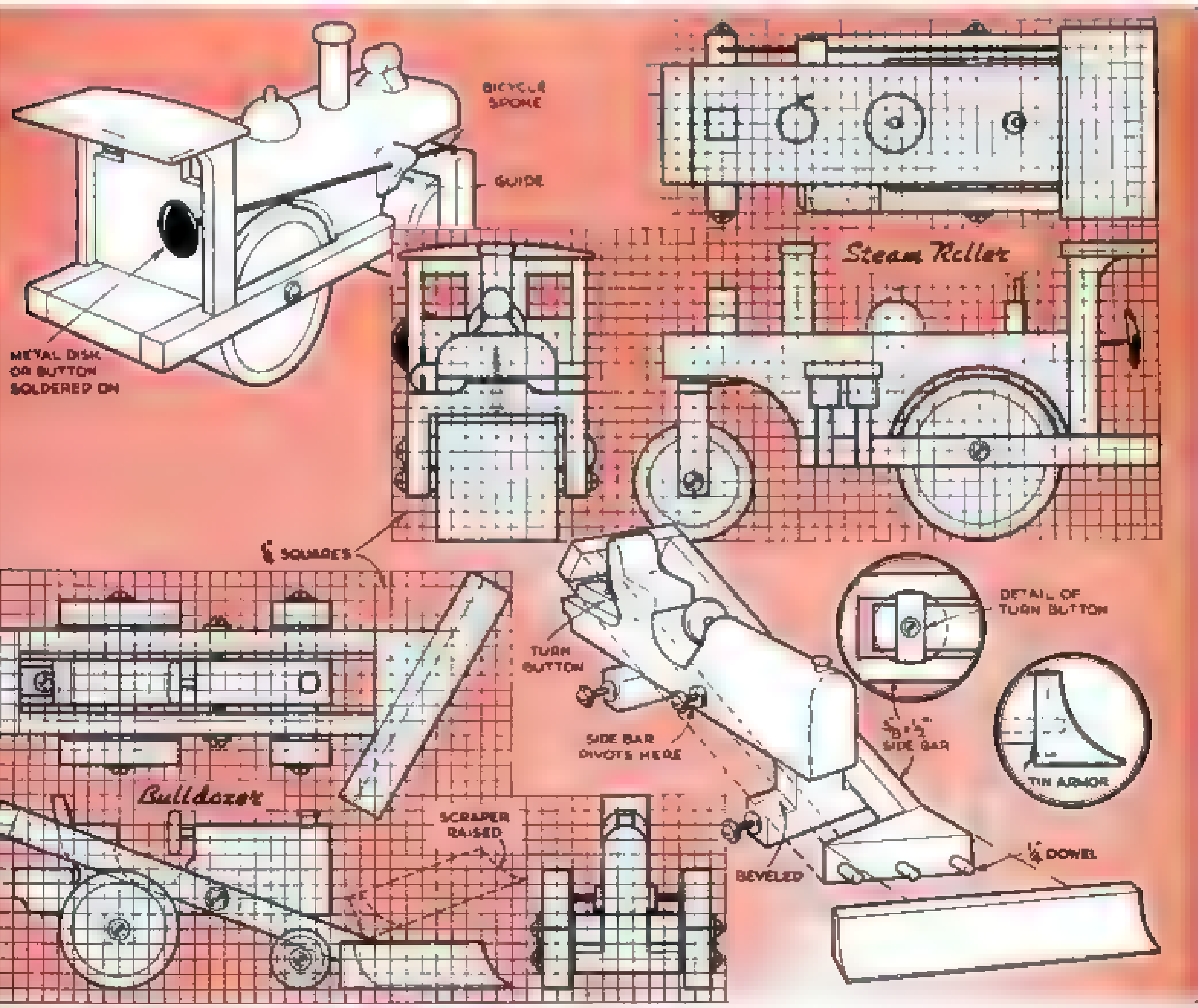
LOADING MACHINE. Fashion the frame and then install two wooden drums to carry the canvas conveyor belt, which should be tight at first because it will loosen in use. Note that the side members of the machine are slotted to permit the placement of the drums with the belt already in position. The sand hopper should be removable to provide for the adjustment of belt or drums.



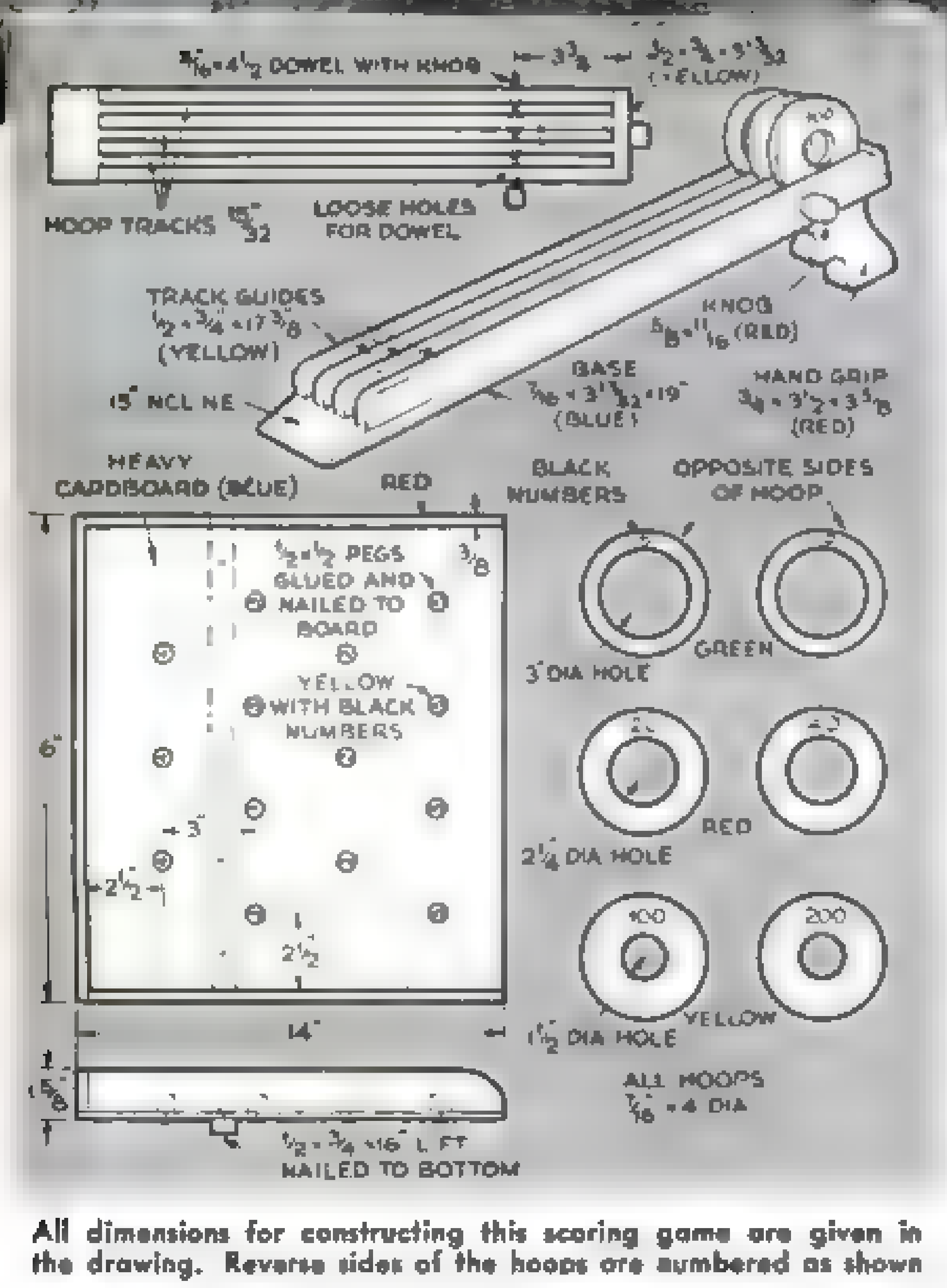
STEAM ROLLER. Even without a spark under its boiler, this steam roller will flatten plenty of sand. Cut the boiler from 2" pine, and mount the stack, dome, whistle, and headlight. Make the side frames and cab of ⅛" material, and install cylinders on one side. The front fork, made of ½" plywood so it won't split, turns on a screw. Lacking a lathe, you can shape the rollers with a knife. Molten lead, poured in holes drilled in the sides of the front roller, will make its weight felt.

BULLDOZER. This little road machine will perform in its own sphere much like its full-sized counterpart, pushing sand aside with a scraper blade that can be raised or lowered at will by turning a button behind the seat. Scroll-saw the body from ¾" stock and install the wooden axles rigidly for the sake of simplicity. The wheels are wood disks, 7/16" thick, turning on small screws. The scraper, sheathed with tin to resist wear, is secured to the side bars with dowels through a triangular block. A snappy paint job is invited by this apparatus, and a yellow body, black side bars, and red wheels with gray tires will make it stand out. Tin for the blade can be cut from a can, the curve being about right. This piece should be fastened tightly to the blade by means of small screws.





TWO NEW INDOOR GAMES ARE . . . *Exciting*



All dimensions for constructing this scoring game are given in the drawing. Reverse sides of the hoops are numbered as shown

HERE are two new games that will take but a few hours to make in the home workshop, yet will afford many hours of pleasure for children and even adults. Both games are modeled on outdoor sports and are designed for indoor play on long winter days.

ROLL-A-HOOP GAME. A pegged scoring board and an incline gun from which hoops are rolled are the parts needed. The gun is made of wood with tracks nailed and glued to the base as indicated in the drawing at the left. Leave space between the tracks for the hoops to roll down without friction, and rub the slots well with wax. Be sure to taper the foot of the base so that the hoops will roll off without bumping.

Three hoops are made, each having a hole of different diameter, and are numbered on reverse sides as shown. They are controlled by a dowel, which can be pulled out slowly to release one at a time, or

Play for Winter Days

rapidly to release all three. Make the scoring board of cardboard with wooden sides, spacing the pegs as indicated in the drawing. Paint in bright, contrasting colors.

To play, place the scoring board on a flat surface, either the floor or a table, stand 2' to 10' away with the hoops in place on the gun, and shoot them at the pegs on the board. A hoop must fall flat on the scoring board to be scored, and the number on the face lying upward is the one that is counted. Should a hoop ring a peg, the number on the upper face of the hoop is multiplied by the number of the peg. The total made by all three hoops is the player's score, and the highest score wins.

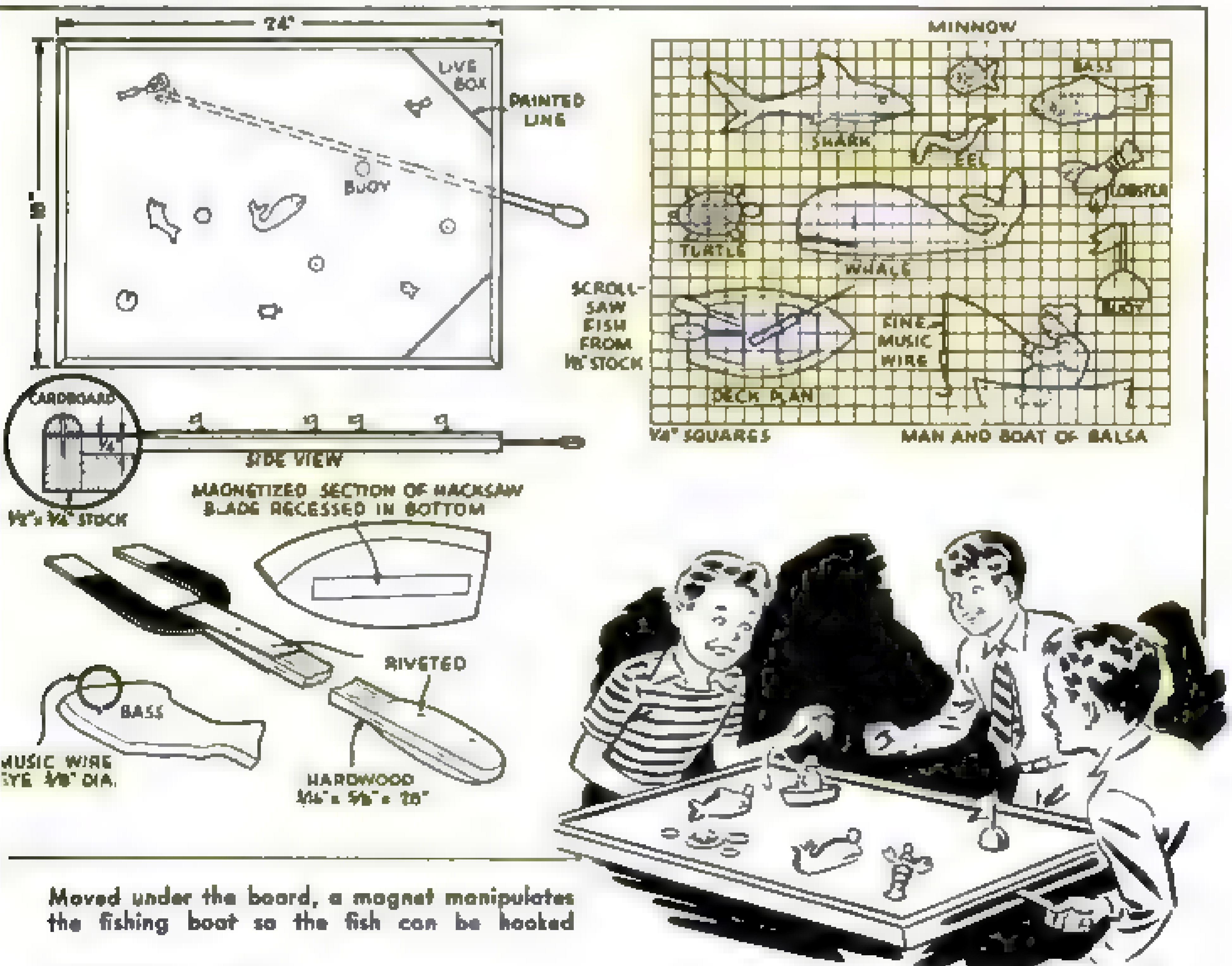
Good technique in shooting the hoops is to pull the controlling dowel slowly after taking aim, and to stop when a hoop begins to roll. The hoops can be made to roll fast or slow according to the angle at which the incline gun is tilted.—MYRON FLEISHMAN.

MAGNETIC FISHING GAME. The little fisherman is maneuvered by a horseshoe magnet on a handle; the player attempts to hook fish and bring them into the live pool.

Tack thin, coated cardboard on a frame of ½" stock for the pond. The fish are jig-sawed from ⅛" material; the fisherman and boat are whittled from balsa.

Tally numbers, each inked in a circle ¾" in diameter on the pond, have these values: Minnow 1, Eel 2, Lobster 3, Turtle 4, Bass 5, Shark 6, and Whale 7. Make the wire loop on top of the Minnow about ¾" in diameter, and use successively smaller loops on the other fish.

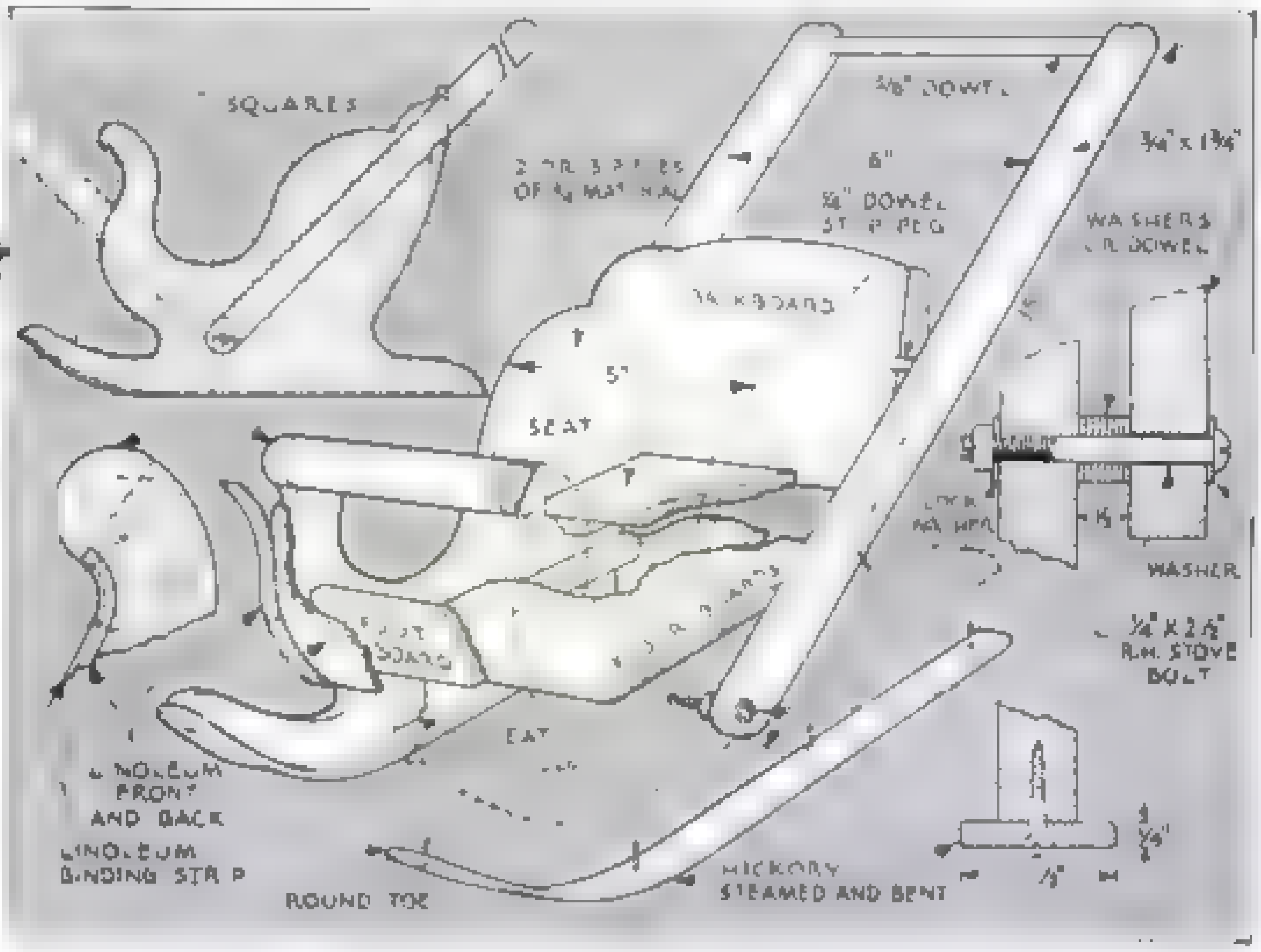
The game is won by the first player to earn 15 points. A player loses his turn when he moves an unhooked fish entirely off its disk or when the boat or a hooked fish knocks a buoy from its unnumbered disk. In addition, a penalty of two points is levied for dislodging a buoy.—LOWELL R. BROWNE.



Moved under the board, a magnet manipulates the fishing boat so the fish can be hooked

Push-or-Pull Child's Sleigh Has Ski Runners

THIS comfortable little sleigh for a small child has ski-type hardwood runners that allow it to be pushed or drawn over soft snow with little effort. Only 24" long, the sleigh can probably be made of scrap lumber now in your bin of odds and ends. Use linoleum to sheathe the curved dash and back; it should be warmed before bending and fastened with regular linoleum binding strips. The handle, which serves for either pulling or pushing, rests in the pushing position against two stop pegs. An additional handle catch to keep it from riding forward when pushed is optional. Finish the sleigh off with a bright red or a light blue and decorate it with decalcomania transfers.



To make the sides of this child's sleigh, several pieces of ¾" wood are doweled and glued together, after which they are cut to the pattern

---

DECEMBER CHECK LIST *[SHIPSHAPE HOME]*

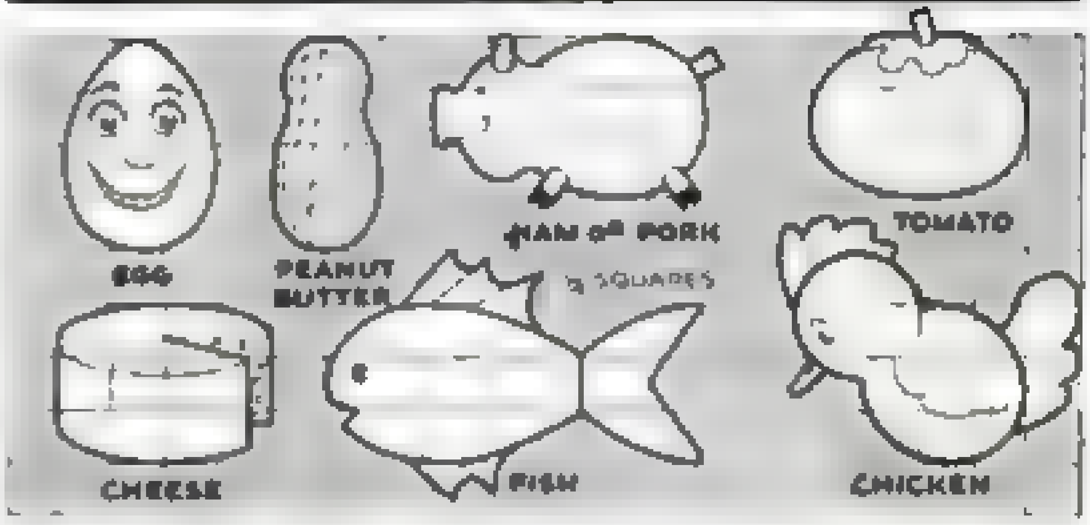
1. Tighten hinges and fittings on garage doors.
2. Be sure tree branches give clearance for electric wires.
3. Stop any leaks in house roof with fireproof material.
4. Inspect and refill or recharge fire extinguishers.
5. Remove trash, papers, and rags from basement and attic.
6. Provide metal containers in which to put ashes.
7. Check on weathertightness of basement windows.
8. Inspect basement stairs and banister for sturdiness.
9. Oil and store lawn mower and garden tools in a dry place.
10. Inspect insulation in basement above heating plant and on pipes.

POPULAR SCIENCE MONTHLY SHOP DATA

HAM, CHICKEN, EGG, OR CHEESE?

TOOTHPICK TOTEMS

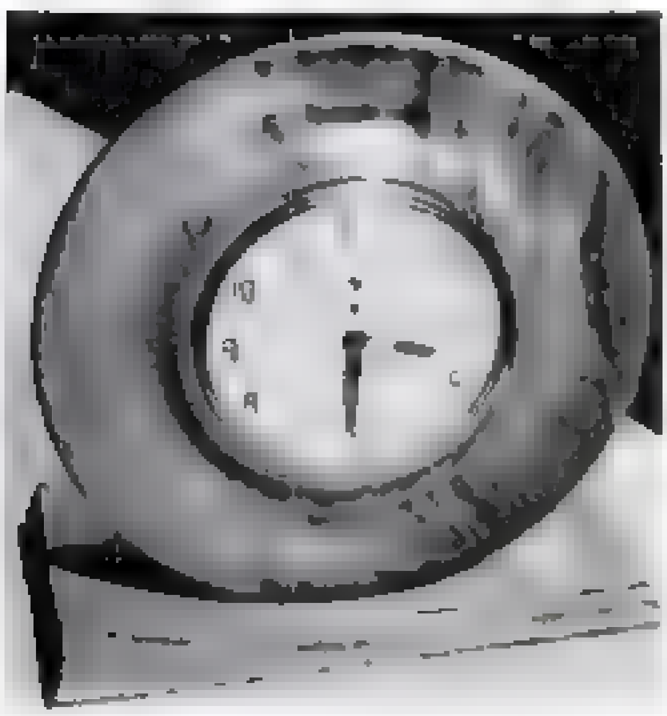
MARK SANDWICHES FOR YOUR GUESTS



These significant little symbols will leave no guest in doubt when selecting a tidbit from a plate of luncheon sandwiches

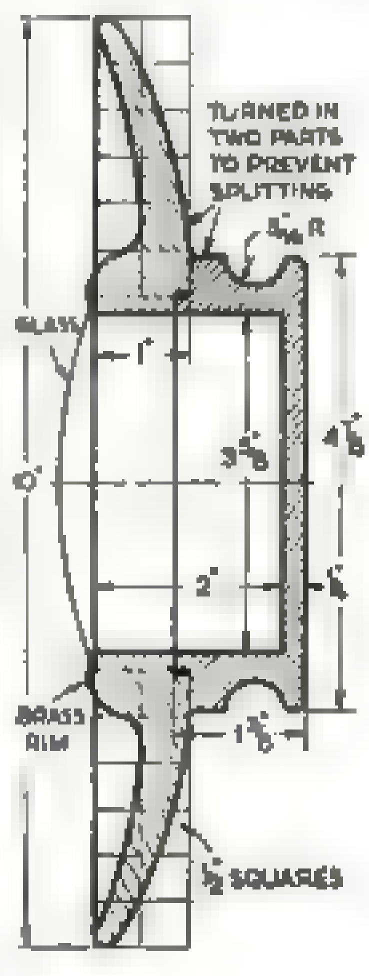
GUESTS will be able to select their favorite sandwiches quickly at a luncheon if atop the sandwiches are mounted these amusing little figures. Those shown in the photograph are turned from soft wood, with a few bits of cardboard added. For the chicken, fish, and tomato markers, cut the comb, tail, fins, and stem from cardboard and glue them into slots in the turned portions. The stem of the tomato is a short piece of round toothpick, as are the pig's ears, feet, and tail. A 1/2" section of a 3/4" dowel, with a wedge-shaped piece cut out, forms the cheese marker.

If desired, the complete figures may be jigsawed from 1/8" wood rather than turned. All the markers should be mounted on cocktail toothpicks glued into holes bored in the underside of each figure, and painted with bright colors, followed with a final finish of clear shellac, varnish, or lacquer. If the stems fit tightly but are not glued in, new ones can be inserted each time the markers are used.—ELMA WALTNER.

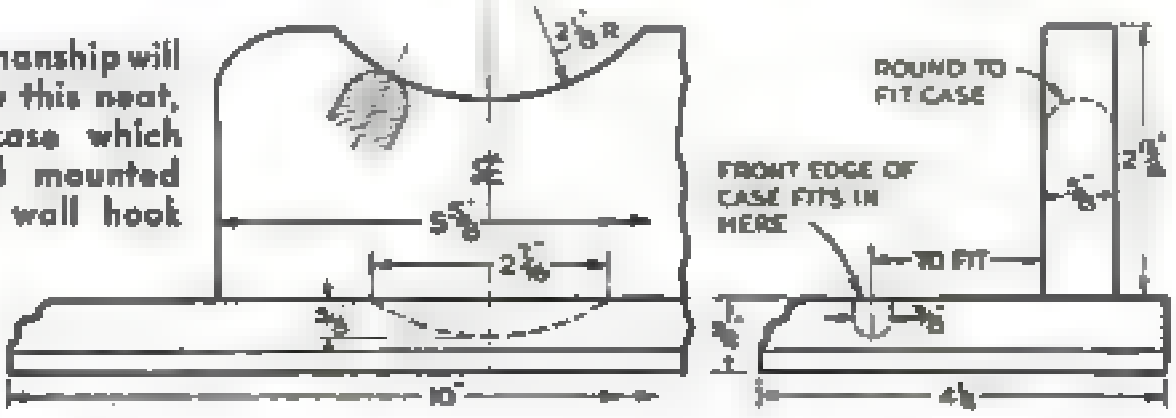


Clockcase Can Be Mounted Two Ways

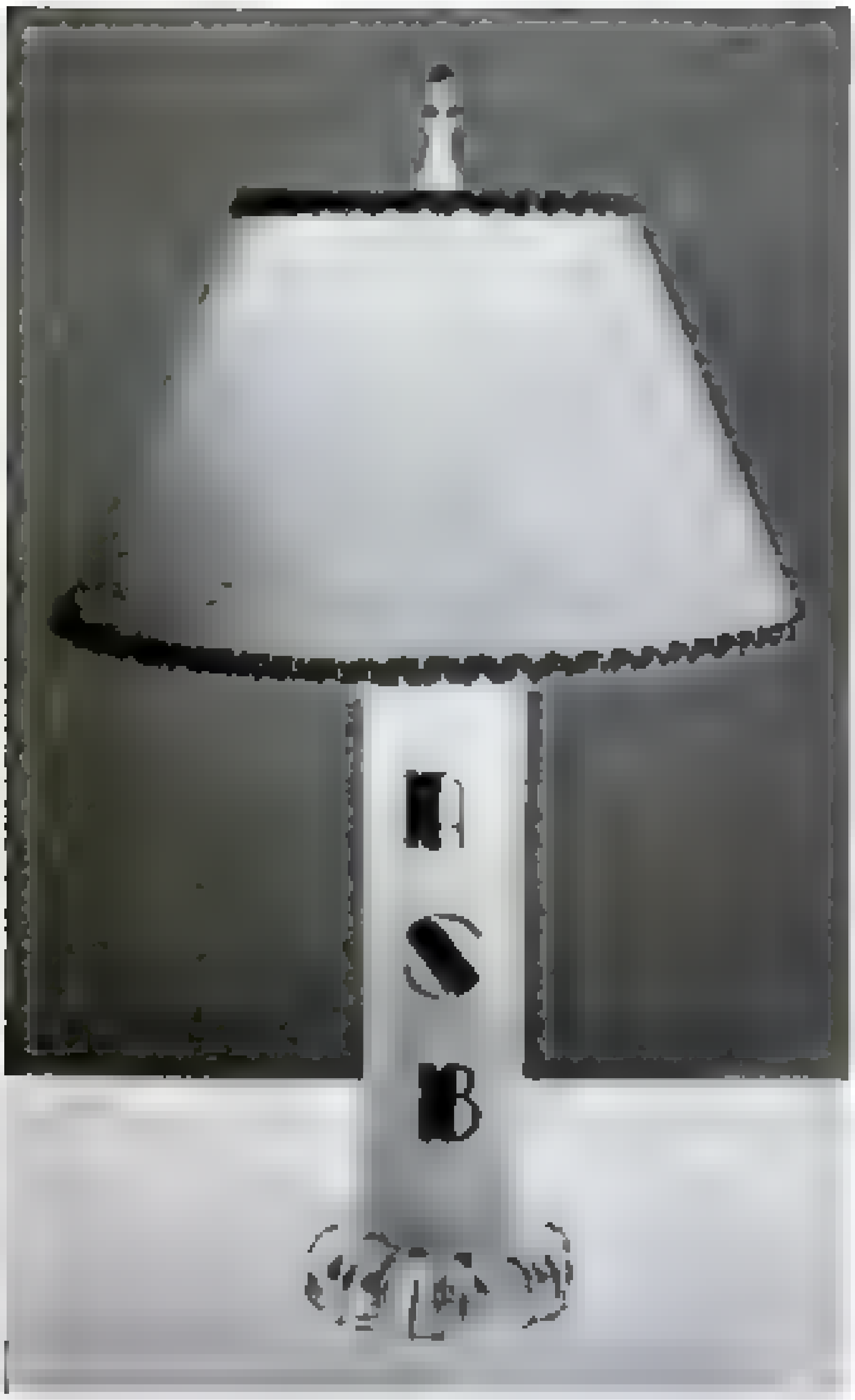
BLACK walnut or mahogany are woods well suited for the making of this plate-type clockcase, which is almost entirely a turning project. The case may be hung on a wall or supported by means of the polished wood pedestal shown in the drawings. Either an electric or a key-winding clock can be housed in the case, the dimensions of which can easily be altered if necessary to accommodate the clockwork. The piece warrants painstaking workmanship and a fine polish.—J. I. SOWERS.



Painstaking workmanship will be well repaid by this neat, hardwood clockcase which can be pedestal mounted or hung from a wall hook



Occasional Lamps from



TWO ATTRACTIVE ACCESSORIES

ATTRACTIVE table lamps, handsome enough to be a decorative feature of any household, can be fashioned from such materials as rolling pins, cardboard, and moldings, all inexpensive and easy to obtain.

The initialed lamp above can be constructed by combining a rolling pin for the column with an inverted glass ash tray for the base. For the lamp with the reeded column on the facing page, two circular disks ¾" thick and 4" in diameter, plus 19' of ½" half-round molding, are required.

To make the reeded lamp, drill holes in the centers of the disks and mount them 6¾" apart on a ½" dowel, as in Fig. 1. This dowel is merely for convenience in handling, and will be removed and discarded later. Next (Fig. 2) glue a piece of strong paper, like that used for filing folders, to the disks to form a cylinder, using tacks to hold it until the glue sets.

Cut 27 pieces of ½" half-round molding each 8¼" long, and glue them to the cylinder, nailing the ends to the disks with small finishing nails, as in Fig. 3. If the 27 pieces of molding fit too tightly around the disks, some of them should be dressed down with sandpaper so they can be nailed into place easily. Small cracks between the moldings won't show in the finished piece because the paper backing will hold sufficient paint in the crevices to conceal them.

The temporary dowel is now no longer needed to hold the disks rigidly in position. Remove the dowel and introduce electric cord through the holes which accommodated it, first slotting the bottom disk sufficiently

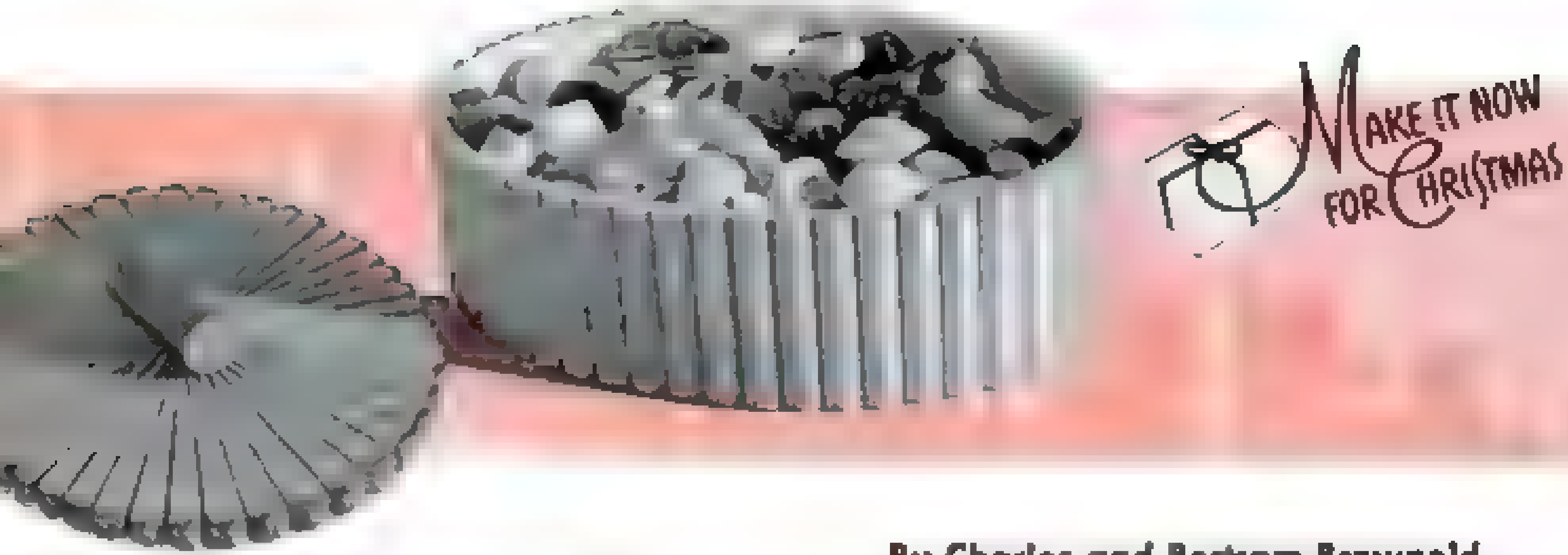
THAT WILL DO MUCH TO BRIGHTEN THE MODERN LIVING ROOM

to admit the cord between the base and table. Any available fixture may be used.

In making the initialed lamp, first remove the handles from the rolling pin and the dowels on which the handles turn, and then fit hardwood plugs into the roller. Drill one plug to take a threaded nipple suitable for a lamp-socket assembly. The other nipple, which is at the bottom and through which the electric cord runs, will have to be long enough to extend through the bottom of the ash tray and accommodate a leather washer and nut.

A hole must be drilled through the ash tray, and a three-cornered file, with its end ground or broken off, makes a good tool for the purpose. Select a file of proper size and use it in a chuck as you would any drill, but first make a ridge of putty around the location of the hole and fill the space with turpentine. Drill slowly and, when the file begins to break through the glass, turn the tray over and finish the drilling from the other side. Renewed "bite" may be given to the file by occasionally breaking off bits.

Wide selections of shades and finials for the topping off of your lamps are available at small cost, and some may suggest variations of these designs. A flaring shade might flatter the slender column.—B. B.



By Charles and Bertram Brownold

DISTINCTIVE Gift Boxes MADE FROM MOLDINGS

DECORATIVE little gift and dressing-table boxes, strong and durable despite their delicate appearance, can be made from ordinary lumber-yard or picture-frame molding.

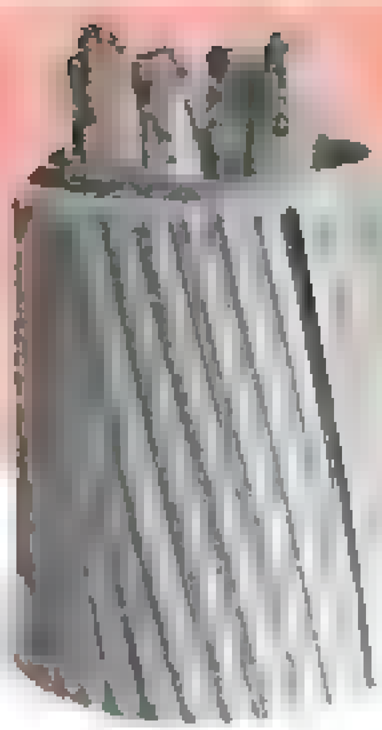
Nail lightly together two pieces of ½" wood, mark the end outline of the box you wish to make on one side, and cut to this on a jigsaw or bandsaw. Then separate the two pieces, which will constitute the top and bottom of your box. The next step is to block the pieces apart, the size of the spacer block used depending on the depth desired for the box. Be sure that the block is perfectly square and that the upper piece is centered exactly over the lower.

Sides for the box are next cut from any material which is thin, flexible, and fairly strong. Celluloid, fiber board, sheet plastic, thin linoleum, or several thicknesses of cardboard glued together will all serve nicely. The width of the sides will be equal to the length of the spacer block, plus the thickness of the top and bottom pieces, plus 1/16" allowance for sanding. The sides are glued to the box, being held in position with tacks thrust through small squares of cardboard. When the glue has set, remove the tacks,

Half-round molding, which gives the boxes their unusual appearance, is available in a variety of shapes and sizes. To conform to curves, it should not be wider than ½"

Shown below is a partly completed box. A temporary spacer block holds the top and bottom in the proper relationship while the sides and molding are added

The radiating grooves that are on the cover of the bonbon box at the left were made by a triangular file. To get the spiral effect at the right, molding is applied diagonally

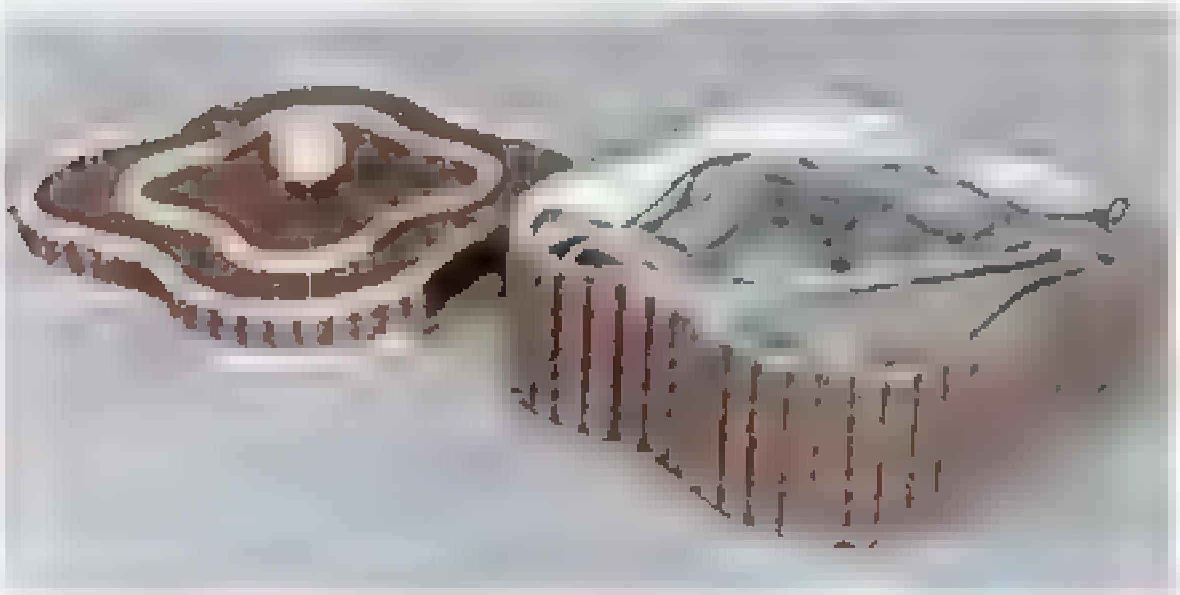
first tearing out the cardboard squares to permit a purchase under the tack heads.

Glue to the sides of the box lengths of narrow half-round molding, available from lumber yards or the makers of picture frames, and usually costing from one to three cents a foot. It isn't wise to use any molding which has a width greater than ½" if the box you are building has curves of short radius. In computing how much molding will be needed, measure around the curves of the box with a flexible tape, and divide this distance by the width of the flat surface on the molding chosen. If the quotient ends in a fraction, sand the edges of some strips so that a whole number of them will fit evenly around the box. For example, if the perimeter of a box calls for 23⅞ pieces of a certain molding, use 24 and sand a few lightly.

Like the sides, the molding should be cut an extra 1/16" long to allow for later sanding. If the shape of the box permits, the molding strips may be held in place by string while the glue dries. If the outline of the box has any concave portions, small brads may be used to hold the molding. Still a third method is to make a gluing jig from the waste pieces resulting when the top and bottom were sawed out. Should the molding be applied diagonally to give a spiral effect, it should be soaked in water until sufficiently pliable and the glue used should be stiff to compensate for the extra moisture

When the glue has set, cut the box apart with a fine cabinet saw and remove the spacer block. As shown in a photo below, a simple jig will be a help in making this saw cut. If the lid is cut close to the top, glue a piece of plywood to the underside of the top so as to form a shoulder to guide it when it is fitted on the box. If the lid is cut deeper, glue a vertical strip of cardboard inside either the lid or the box proper to form a shallow rabbet. Sand the completed box thoroughly, being careful to remove all excess glue, and finish with varnish or enamel.

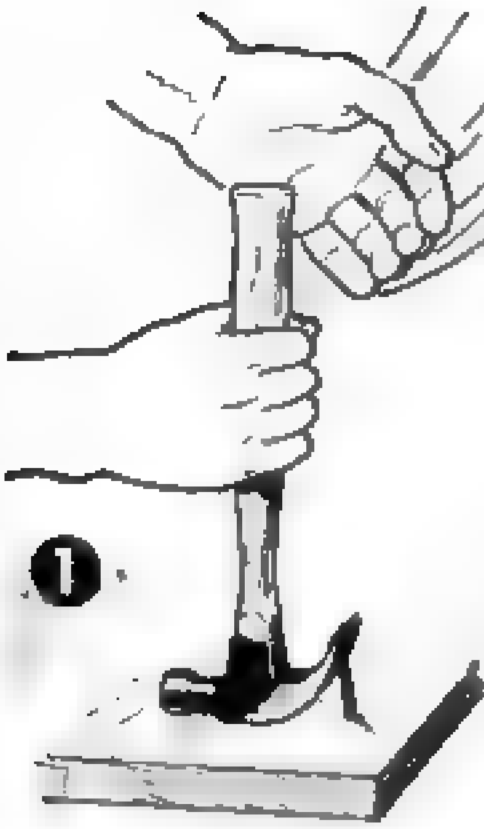
Alternate types of molding help to decorate this handkerchief box



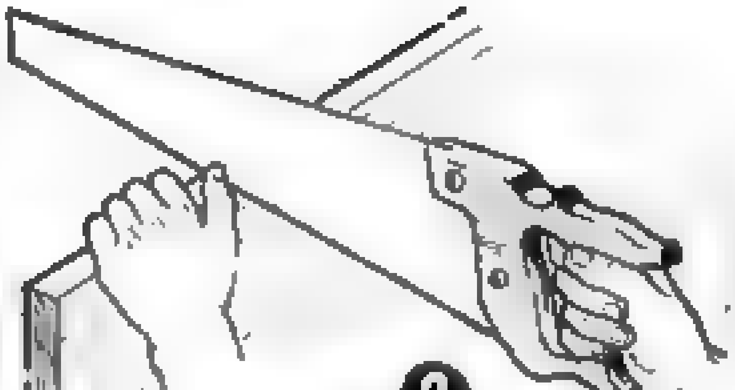
An L-shaped jig is convenient in cutting the top off the box. In making such a jig, use wood that is as thick as the finished box top is to be deep

Shaped to the curves your fancy dictates, these boxes make distinctive and useful dressing-table accessories

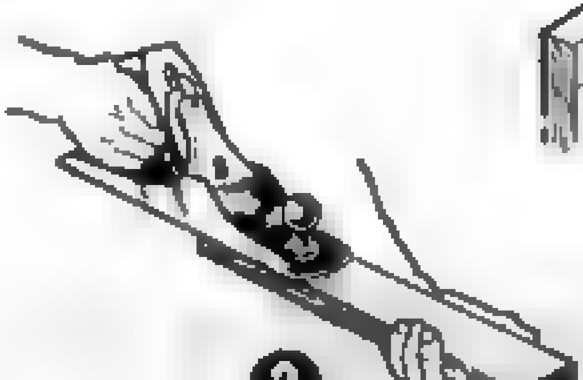
What's Wrong?



1

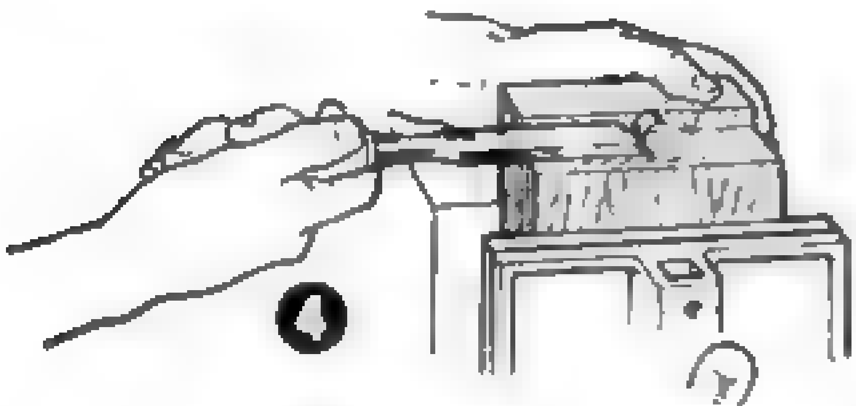


2

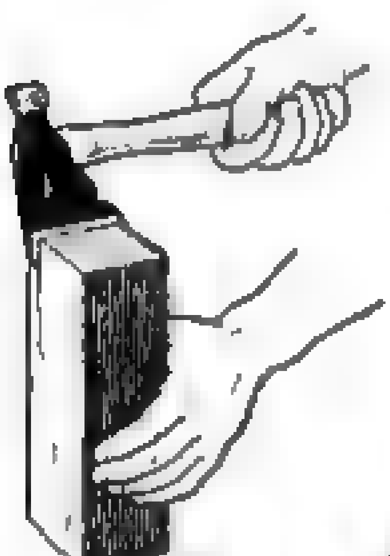


3

5



4

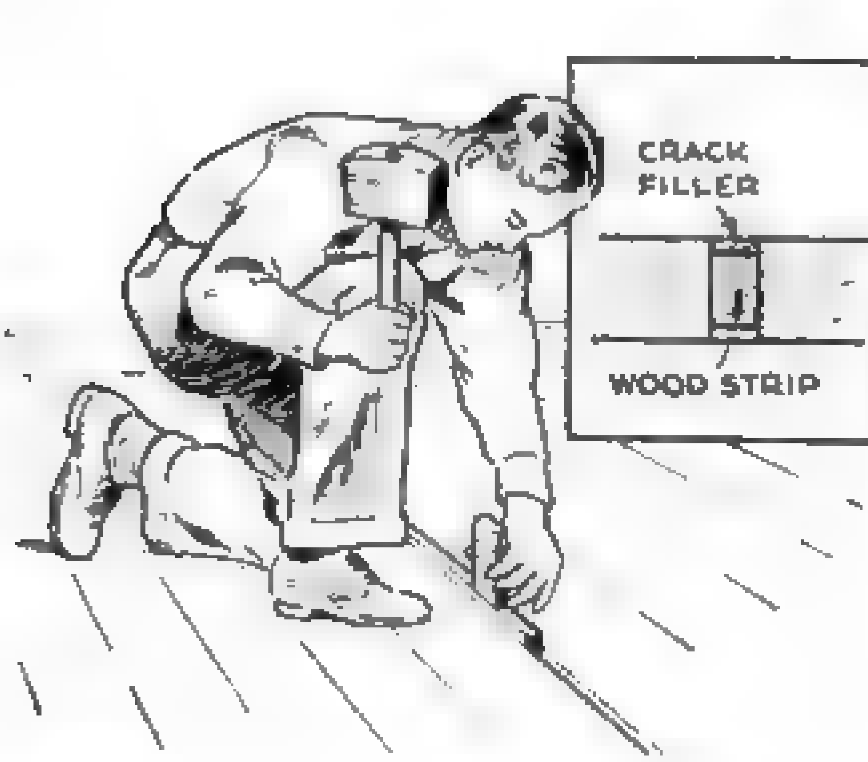


6

7

Each of these sketches shows some carpentry work being done incorrectly. Can you find the errors? The correct answers are printed upside down below.

1. Striking the handle can make the nail fly up in your face. Use a block under the head to pull big nails. 2. A bad cut may result if the saw jumps off. Nail or hold on a strip as a guide. 3. You may slice finger tips and thumb. Lay thin strips down for planing. 4. Keep both hands on the chisel and you won't cut yourself if the blade slips. 5. Your knee can get a bad blow if the hammer glances off the nail. It's safer and less tiring to nail flooring standing up. 6. If the wood splits crookedly, the blade may cut your hand. Hew from the bottom up. 7. Avoid splinters by using a stick or brush.



LARGE CRACKS IN OLD FLOORS can be patched without removing the boards, even though the cracks may be too wide to hold ordinary filler. First, nail down any loose or squeaky boards, as such boards will not hold filler. Clean all cracks. Then saw strips of soft wood to fit the cracks and bevel these strips slightly with a plane. Apply glue and drive them into the cracks with a wood wedge and a mallet, setting them ⅛" below the surface. Shellac this trough and fill it with commercial filler, building it slightly above the surface. When it is dry, sand the filler level with the rest of the floor. RALPH S. WILKES.

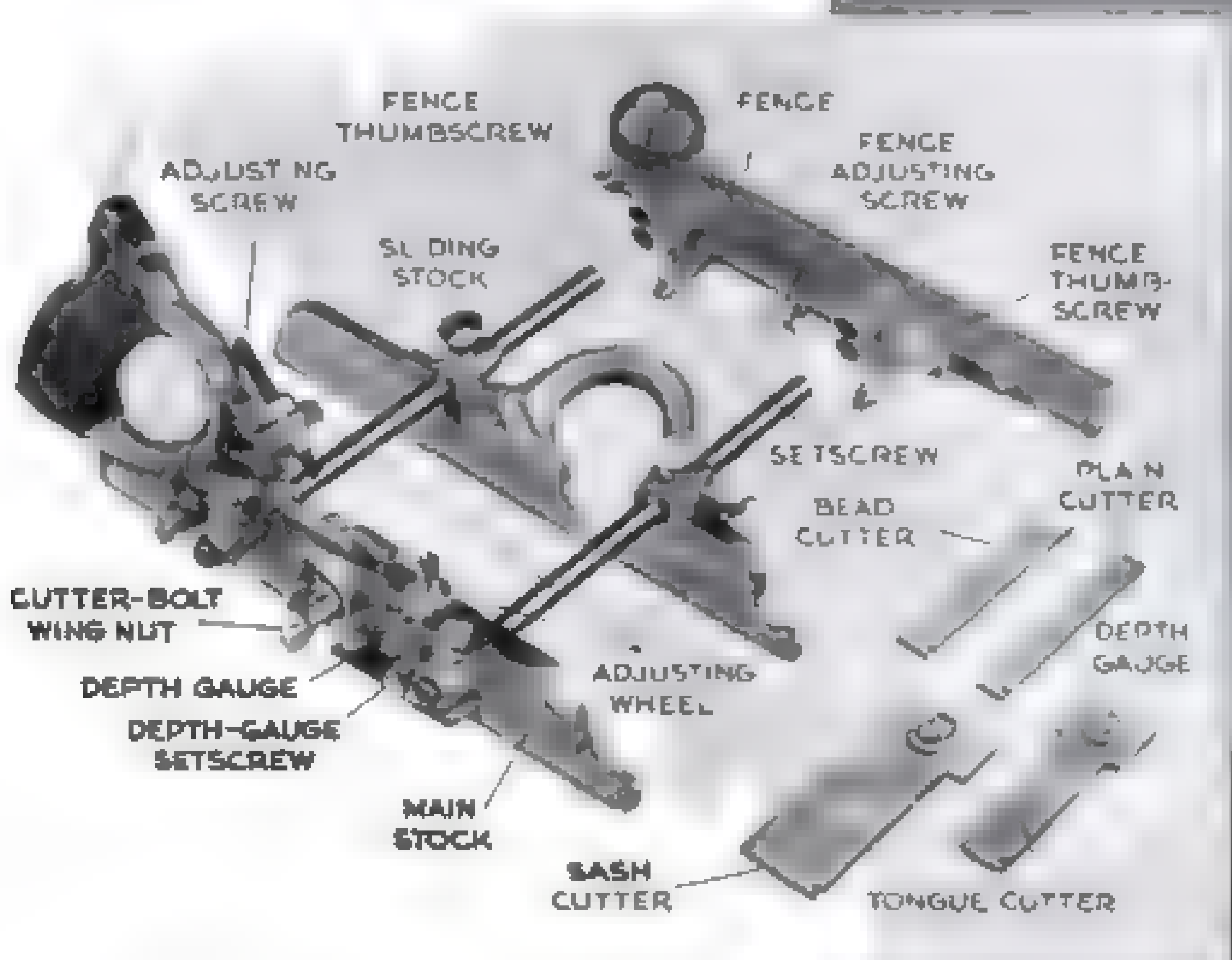
Grooving and Rabbeting
WITH A COMBINATION PLANE

RABBETS and grooves are needed so frequently in woodworking that the home mechanic should be equipped to make them accurately and quickly. They can be cut with chisels, but special planes will save time. A rabbet and fillister plane is adjustable for making rabbets of various sizes, and a dado plane cuts grooves the width of the plane. Still more elaborate, a combination plane is used for rabbeting, plowing, beading, fluting, and tonguing on both light and heavy work. A router plane is useful for chipping out dadoes and for leveling recesses.

How is rabbeting done with a combination plane? Loosen the fence and the sliding-stock thumbscrews, and back away the wing nut on the cutter bolt. See that a point of the spur in the main stock projects downward. Select a cutter somewhat wider than the rabbet to be made and insert it in the clamp with the notch engaging the pin in the adjusting screw; then tighten the clamp just sufficiently so that it will hold the blade and still allow it to be advanced or retracted for adjustment.

Move the sliding stock to the left, to clear the work, and lock it. Place the fence in position and tighten its screws; then complete the adjustment with the adjusting screw and lock the fence in place. Set the

By EDWIN M. LOVE



Many operations in cabinetwork are possible with this combination plane. The fence is reversed in the photo to show its adjusting screws. Typical cutters are also pictured

Rabbeting is simple with a plane of this type. The cutter chosen should be somewhat wider than the rabbet so it will clear the side of the stock and leave a clean edge. Test the setup by rabbeting on scrap first

depth gauge and check the setup by cutting a test rabbet in scrap wood.

Stock must be rigidly held in such a manner that the fence can slide along it, and the fence must be pressed firmly against the work. Take as heavy a shaving as can be easily managed. If the plane slides sidewise, the spur is dull or out of alignment, or the cutter may not be clamped firmly. Trim out the corner of the rabbet with a chisel and proceed after making proper adjustments.

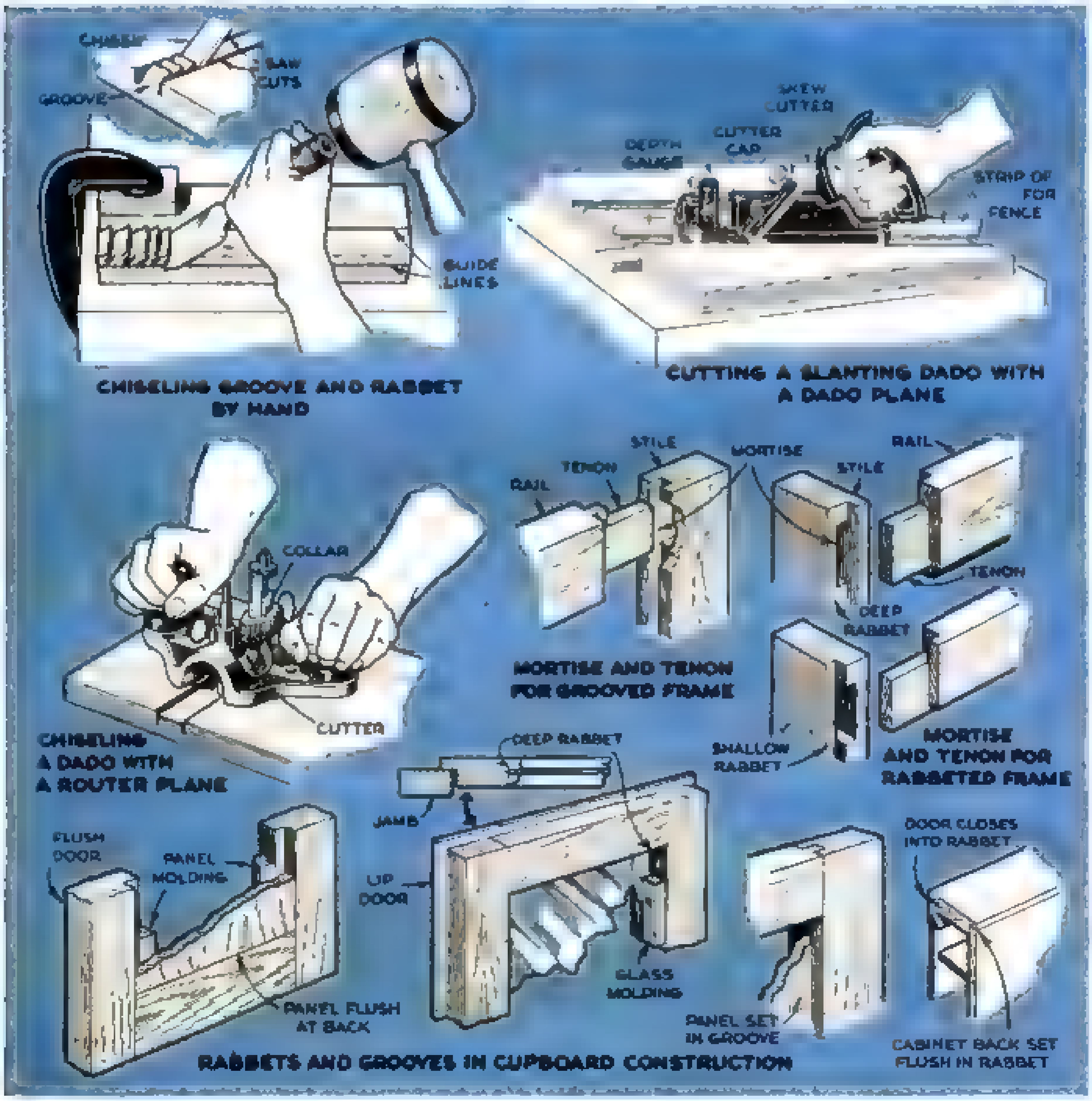
What adjustments are made for grooving with the grain? Choose a cutter equal to the width of the groove, set up the combination plane as for rabbeting, and then, in addition, align the spur of the sliding stock with the left edge of the cutter. Set the fence and depth gauge and plow the groove. If the groove is too wide for your nearest cutter, plow it with two or more cuts.

How are grooves made across the grain with a combination plane? The setup is the same as for plowing with the grain. Keep the spurs so they will sever the fibers without splintering. Clamp a strip at the far edge of the wood to prevent splintering as the plane bit emerges from the cut.

Is it possible to groove the end of a board? If the blade is sharp, it will cut satisfactorily in the end grain. To prevent splintering, clamp a strip to the far edge.

How are tonguing and grooving done? Set up the plane with the tonguing cutter and without the spurs and depth gauge. An adjustable attachment on the cutter regulates the depth of cut by riding on the tongue when full depth is reached. Plow the groove in the matching edge of the mating board to fit the tongue and to bring the faces flush.

How is a rabbet plane used? The cutter



CHISELING GROOVE AND RABBET BY HAND

CUTTING A SLANTING DADO WITH A DADO PLANE

MORTISE AND TENON FOR GROOVED FRAME

CHISELING A DADO WITH A ROUTER PLANE

MORTISE AND TENON FOR RABBETED FRAME

RABBETS AND GROOVES IN CUPBOARD CONSTRUCTION

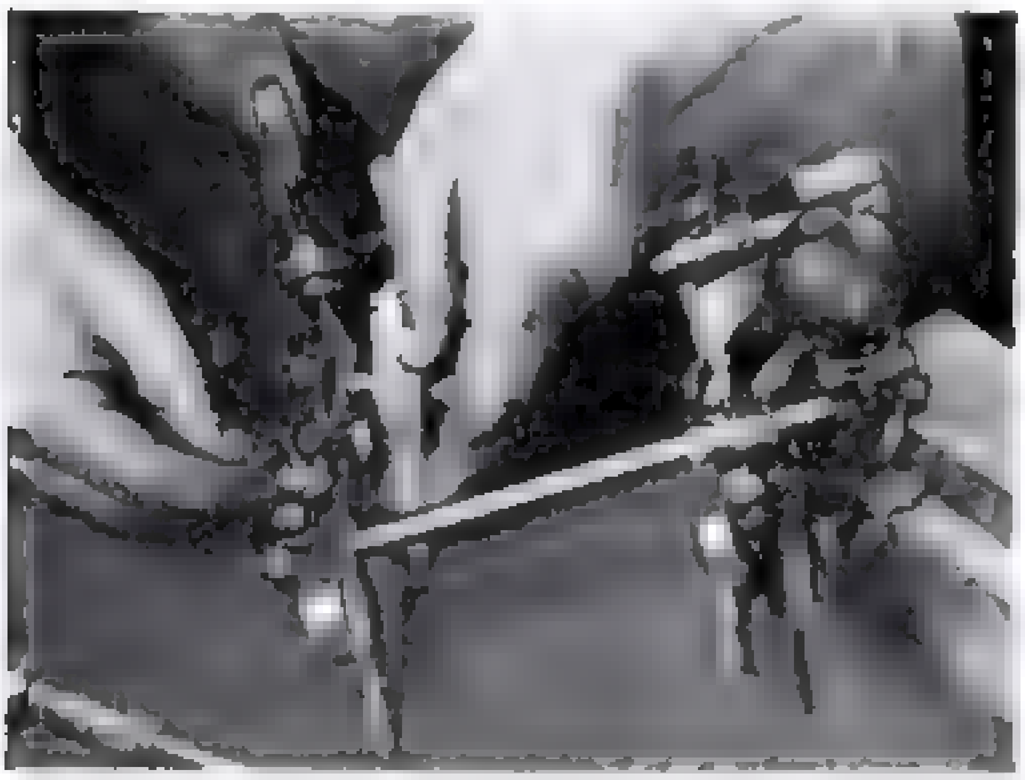
has no depth-adjustment screw and is free to move sidewise until clamped. Whether square or skew, its cutting edge must be parallel to the bottom of the plane. The proper thickness of shavings is assured by first resting the plane on a board and pressing the cutting edge on it while clamping the cap, then by tapping the upper end with a hammer to get bite and by tapping the side, if necessary, for spur alignment.

Carpenters often dispense with the fence by nailing a strip of wood on the work. This allows a tapered rabbet to be made. If your rabbet plane has two seats, the forward position may be used for the cutter to make working in close corners easier.

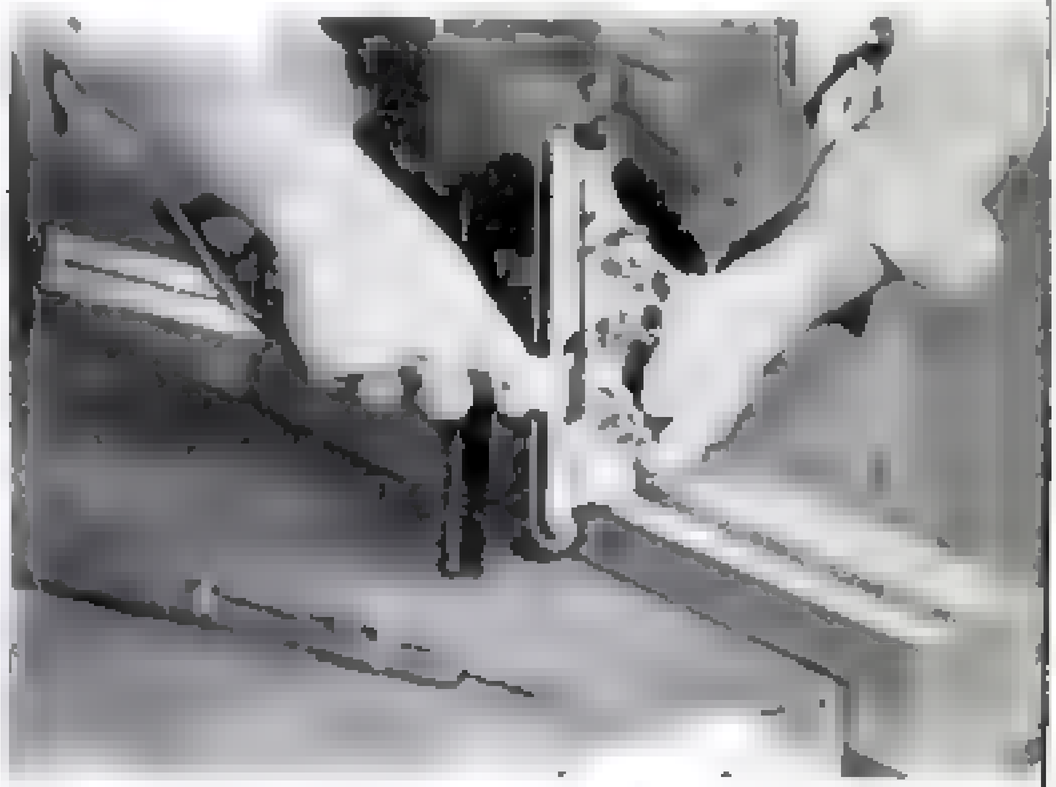
Is a dado plane difficult to handle? It is used much like a rabbet plane and, if properly adjusted, is not difficult to handle. If the sides of a dado are sawed first, a narrow plane can be used for smoothing the bottom of a wide dado.

How do you use a router plane? This tool has no side spurs and can be used only on dadoes or in recessed areas that have been sawed or chiseled at the edges. It is a rapid worker and will cut to depth in one setting, although it is usually best to take a roughing cut first. Screw a wooden bottom to the plane to span extra-wide dadoes.

What are typical uses of rabbets and grooves? Door or sash frames have deep rabbets to receive glass or wood panels, shallow ones for panels set flush at the back. In the former, a tenon is cut on the end projection of the rails; in the latter, it springs from the stepped-back portion. Backs of cabinets are rabbeted for plywood panels. Dadoes and grooves carry drawer bottoms, shelves, and partitions.



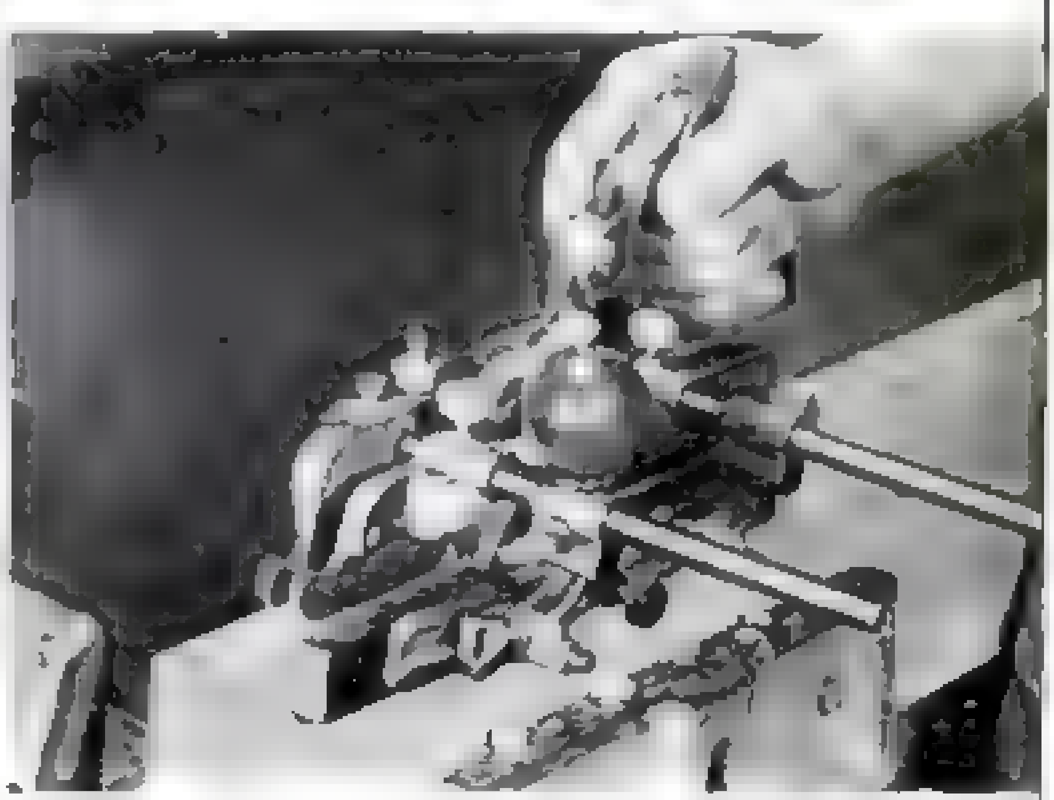
When a cutter is inserted in a combination plane, its notch (shown on the left of the cutter above) should engage a pin in the depth-adjustment screw

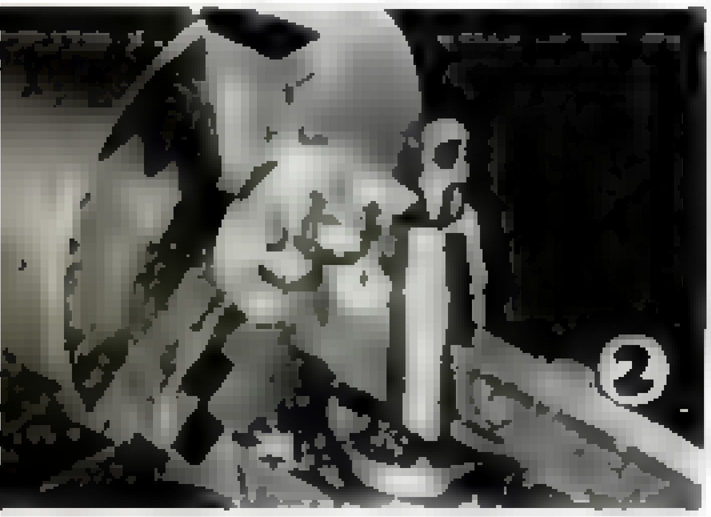


All adjustments must be made with care. Above, the woodworker, in setting the gauge for depth, is correctly measuring to the edge of the cutter

Grooving with the combination plane is similar to rabbeting except that the cutter cannot be wider than the groove. One of the same width is ideal, but several cuts can be taken if it is narrower

Tonguing is done with a special cutter having a notch in the center that leaves a tongue when the parallel rabbets are cut. Depth is gauged by an attachment that rides the tongue at full depth





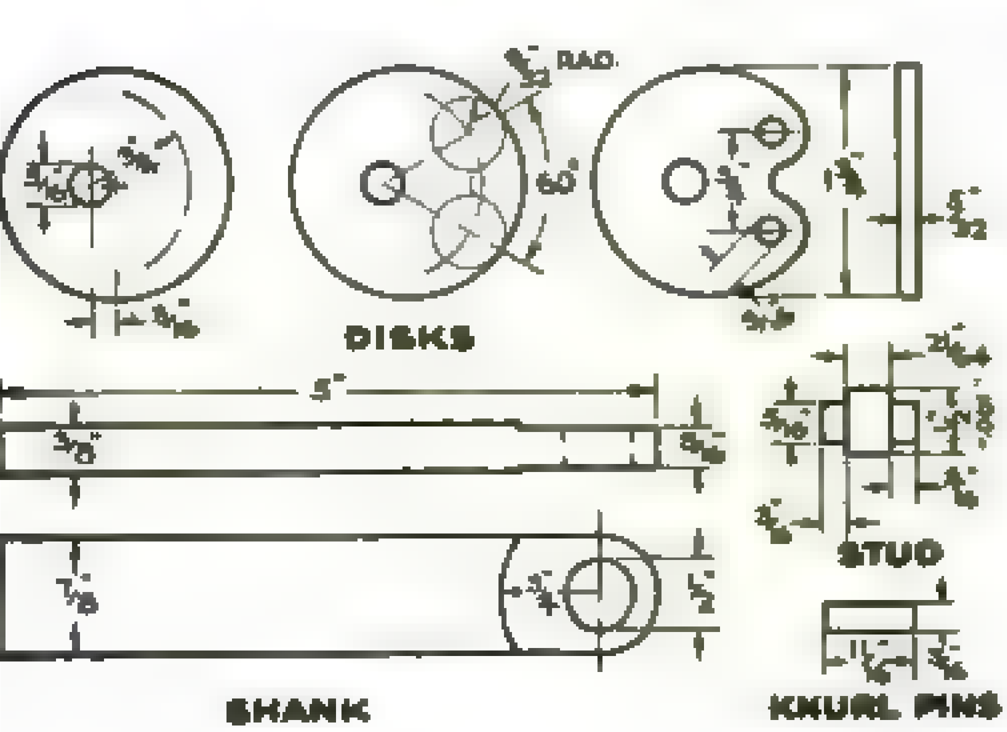
Self-Centering Knurling Tool

By C. W. WOODSON

KNURLING is an interesting operation that will add a finished appearance to many projects. The knurling tool shown above is of the floating type, which allows self-centering of the rollers to insure equal pressure and a perfect diamond pattern. A few short pieces of scrap steel and a pair of hardened, diamond-pattern, standard-faced knurls, which should be purchased ready-made if you do not own a hobbing machine, are all that are required to make it.

Chuck a 5" length of 5/8" bar in the lathe as shown in Fig. 1 and take 1/32" off each side to reduce the thickness to exactly that of the knurls. With the work still chucked, drill the stud hole, starting with a 1/4" drill, opening out with a 7/16" drill, and finally reaming to exactly 1/2". Round the end by hand-filing as indicated in the drawings. File off any burrs and bevel the sharp edges slightly; then draw-file bright all over.

The twin disks that hold the knurls can be made from a short piece of 1 3/4" steel rod cut off and faced smooth, as in Fig. 2. Lay out the stud hole as shown in the drawings, stack the two disks, clamp them together, and drill through both at once. Drive a pin into this hole to keep the disks aligned; then lay out the two knurl-pin holes and drill them to the exact diameter specified so that the pins will be a drive fit and can be removed for changing knurls when necessary. Notch the disks between these holes with a rat-tail file to allow of knurling work that is of small diameter.



Turn the stud from a short piece of 1/2" rod in one chucking. The 1/2" hole in the shank should be used as a ring gauge to assure a fit just tight enough to cause a slight drag when the stud is turned in the shank. This finished stud is shown with the disks, knurls, and knurl pins in Fig. 3.

To assemble the tool, first tightly rivet one end of the stud over one of the disks; then insert the large section of the stud into the hole in the tool shank and rivet the other disk. The pins are driven in after the knurls have been inserted. Shown are medium-size, 21-pitch, right and left-hand diamond knurls. They are interchangeable.

NEW SHOP IDEAS

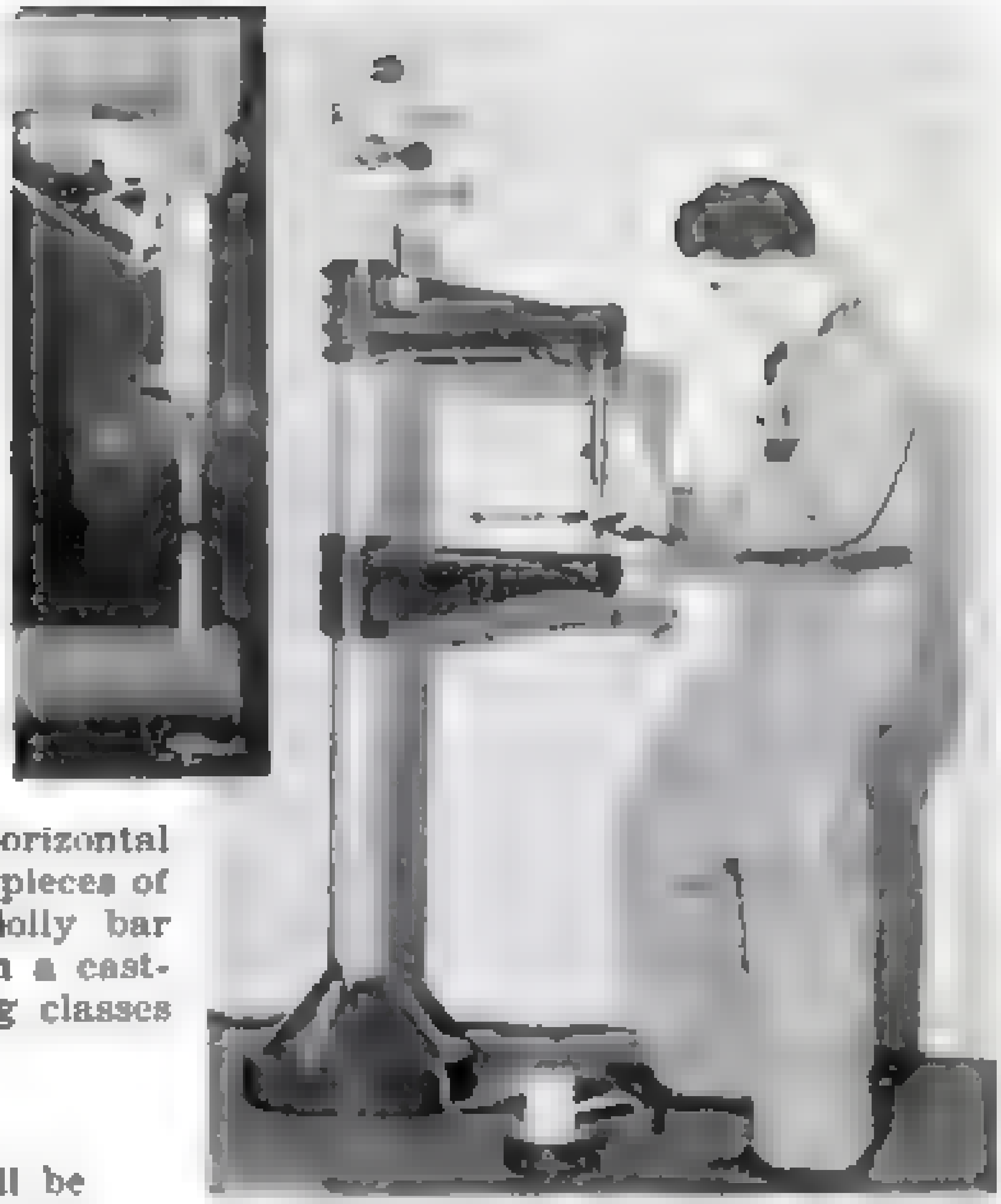
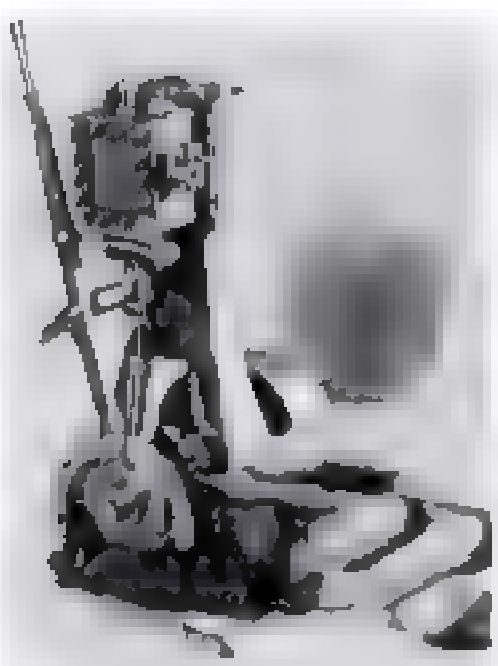
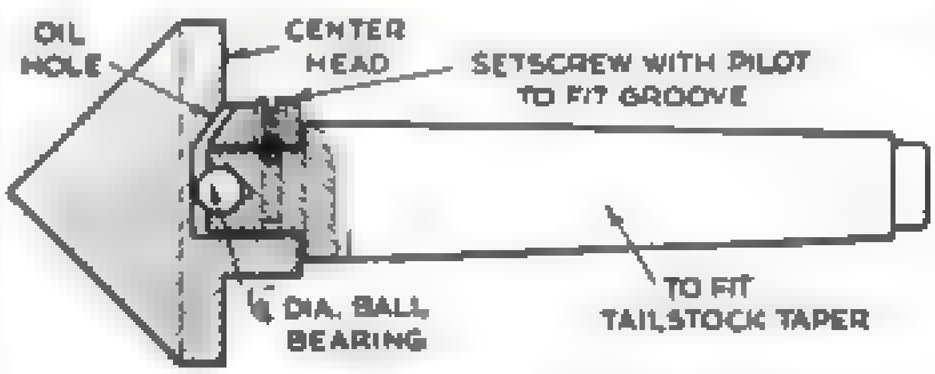


Photo courtesy of Air Reduction Sales Co.

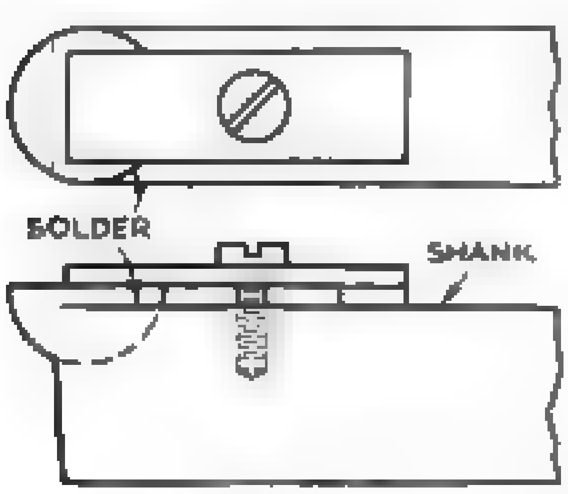
SCRAP MATERIAL was all that was used by the boys of Wilson High School, Jamaica, L. I., to build this riveting machine, which will drive 5/32" rivets as fast as the work can be fed. An old automobile gear was employed for the base, with a cap fitted over it for appearance. Scrap pipe served as the column and as a reservoir for compressed air. The horizontal arms were fabricated from some stray pieces of an airplane landing gear, and the dolly bar backing the rivet was turned out from a cast-off Ford axle. Students in the welding classes assembled the machine.



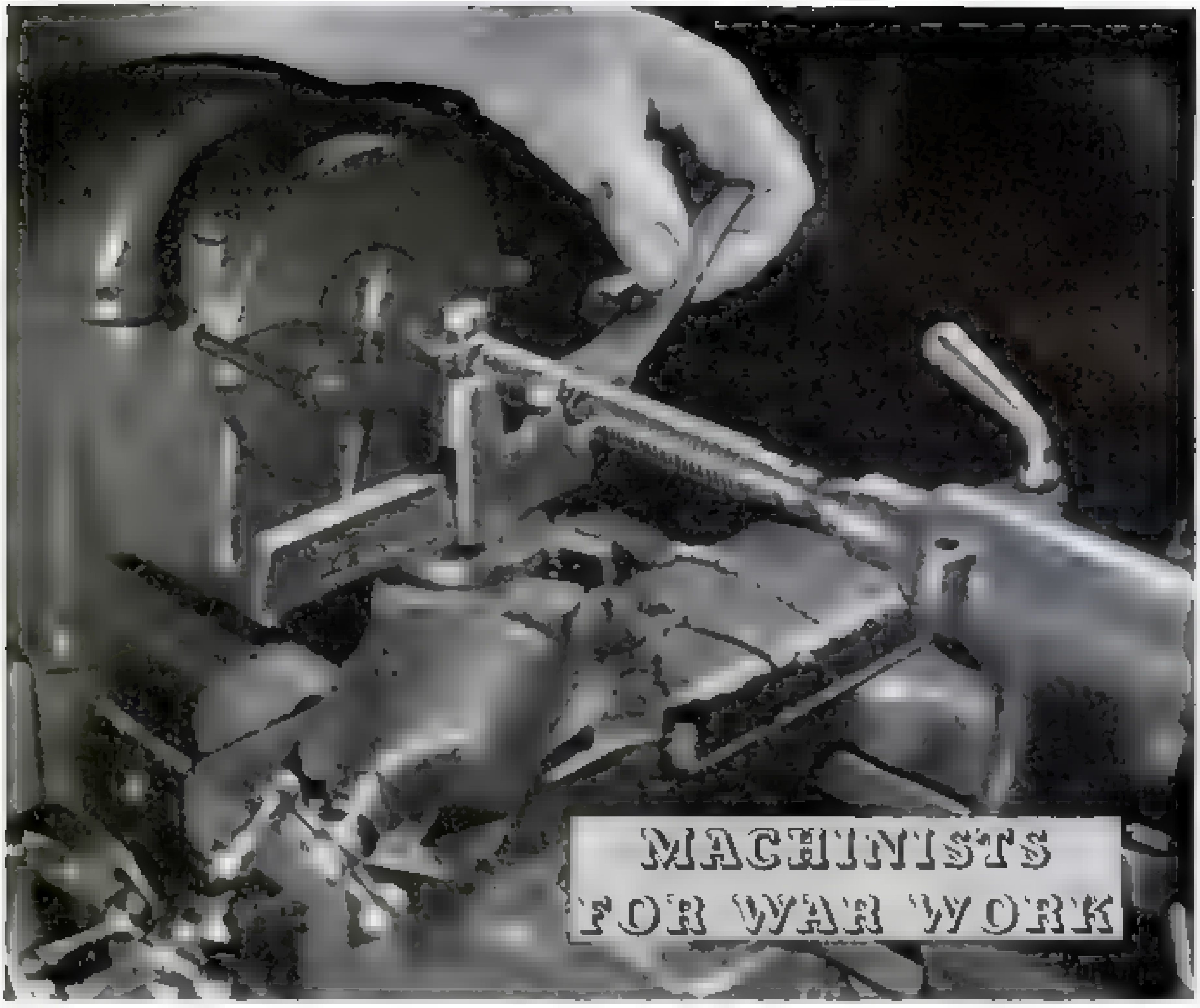
SMALL TAPS will be less likely to break during use if they are chucked in a pin vise, as shown at the left. When used for delicate work, such a vise will forestall any excessive twisting that might result from use of an ordinary tap wrench of T-handle design. Moreover, a better feel of just how much pressure a small tap will stand can be had in this manner, and with a pin vise it will also be found easier to guide the tap accurately into the hole at the start. In tapping small holes, it is of the utmost important to select a drill of the proper size, and to use a lubricant suitable for the metal being worked. Correct drill sizes and lubricants are recommended in various handbooks.—C. W. W.



A LIVE PIPE CENTER constructed like the one in the drawing will prove well worth the making if no die is available for the threading of large-diameter pipe. The one illustrated, designed for 8" pipe, was constructed by turning its shank to fit the tailstock of a lathe. The outer end of the shank was drilled to take a ¼" ball as a bearing for the hardened center head to revolve on as it turns with the work. A setscrew seated in a circumferential slot holds the center head in position on the shank. An oil hole is provided for lubrication.—H. D. CHAPMAN.



ACCURATE RADIUSES can be turned with a tool consisting of a ball bearing and a seat, according to the British magazine *Mechanics*. As in the sketch, the holder is slightly countersunk to provide a seat for the ball, which is then soldered in position. The ball is next ground down to center in its holder. This center line can be checked on a surface plate with a vernier height gauge if extreme accuracy is required. Careful grinding is necessary or the ball may be ripped from its seating. The tool works very well on brass, bronze, and other soft metals.



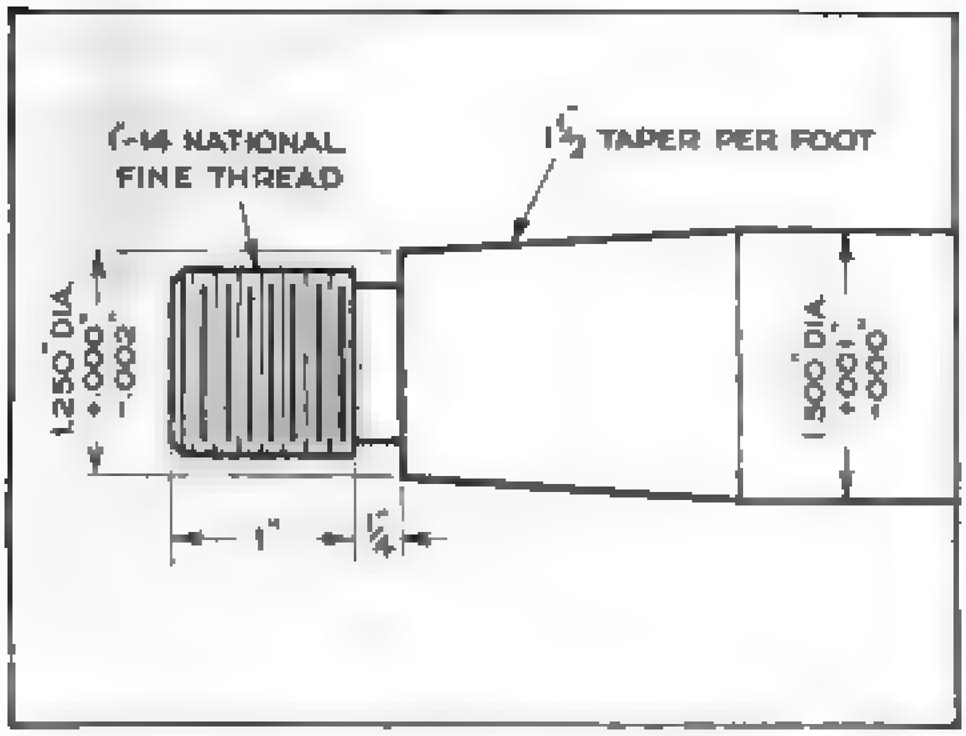
CUTTING THREADS ON A LATHE

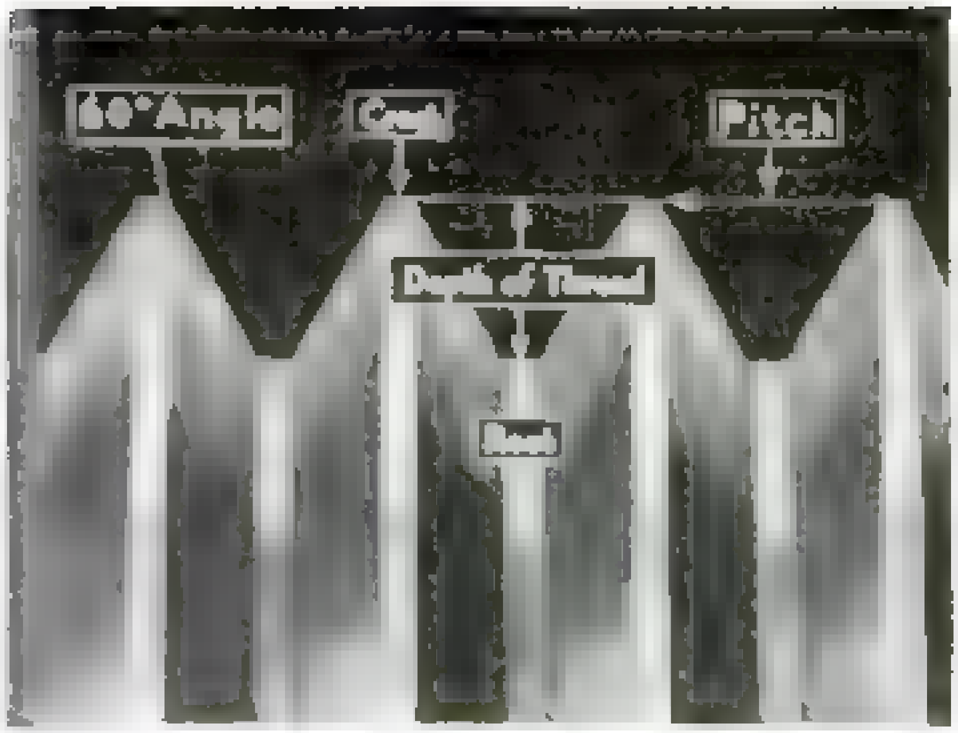
ALTHOUGH threads may be produced by such differing methods as grinding, rolling, milling, or using a screw-cutting die, an engine lathe is almost always used when the threads must be concentric with other turned surfaces.

In cutting an external thread, the tool is fed into the work by means of the compound-rest feed. The compound rest could be set to advance the tool squarely into the work, but it is usually found preferable to set it over 30 deg. The tool then removes metal only with its left-hand edge, and tends to produce a smoother thread than if it were fed straight in. Since the tool in this case moves along the hypotenuse of a right triangle, it is advanced 1.154 times the actual depth of the thread.

The cross slide is used in backing off a tool after a cut has been completed so that the carriage can be returned for another cut. The cross slide is then moved in to its original position, located either by a stop or by a reading on the cross-slide index collar. To prevent the tool from tearing the threads, the lathe spindle speed should be slow; the actual speed for the metal being worked may be obtained from a handbook. The gears which drive the lead screw must, of course, be arranged to produce the specified number of threads per inch.

Since every cut after the first must track in the same spiral, it is necessary to "pick up the thread" each time, that is, to engage the lathe carriage to the lead screw at the proper moment. This may be easily done with a threading dial. If an even number of threads per inch are being cut, the lead screw can be engaged when any mark on the dial comes opposite the index mark. In cutting an odd number of threads per inch, the lead screw is engaged at a numbered mark on the dial. The following photographs, showing the sequence of operations in cutting threads on a lathe, have been taken from a motion picture produced by the U. S. Office of Education and distributed by Castle Films.





1 As shown on the drawing, a 1"-14 National Fine Thread is to be cut at one end of a shaft. This means that the outside thread diameter is 1", and that 14 threads are cut to every inch of the work

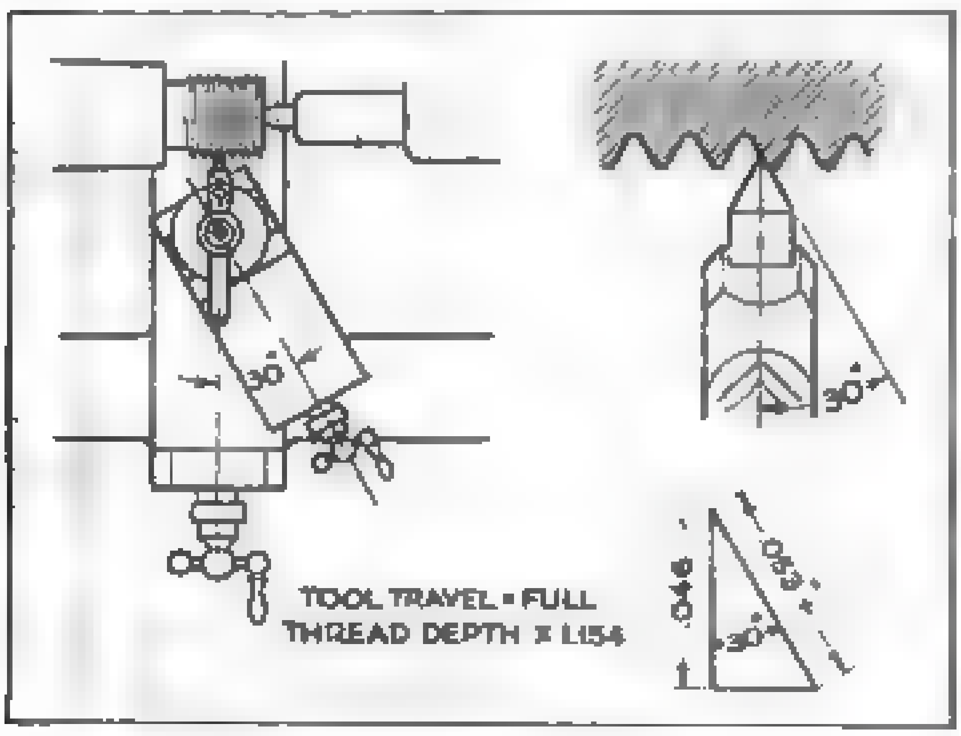
2 A National Fine Thread has a 60-deg. included angle. Other values for this particular thread are obtained from a handbook. The important value to find is the depth, which in this case is .0464"

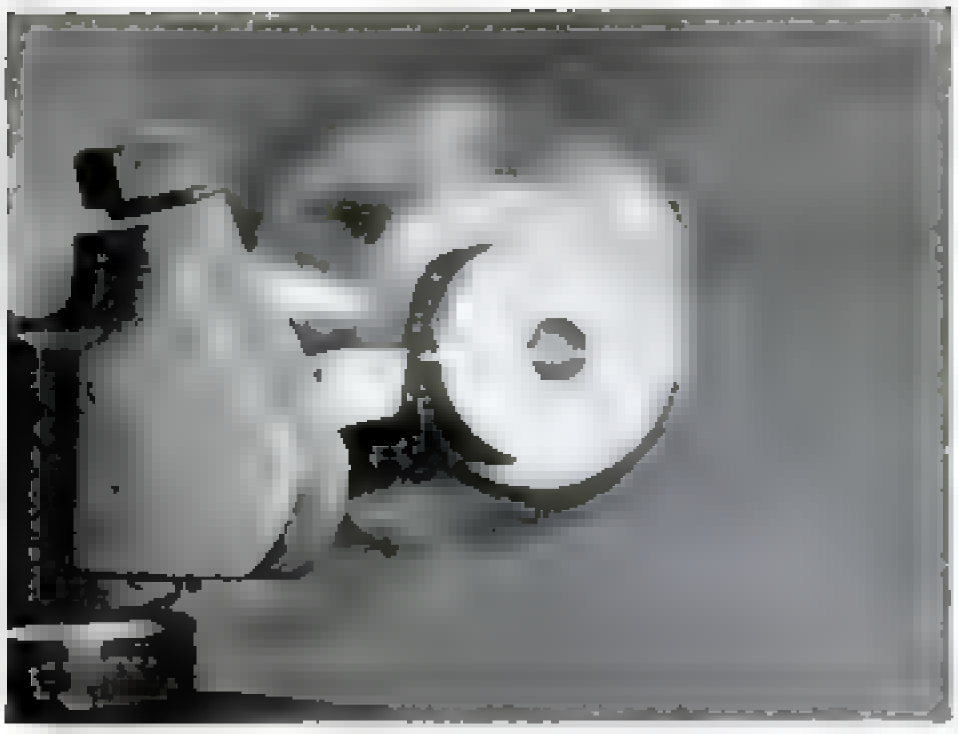
3 Fitted with a dog, the work is set up between centers. The hole in the tailstock end must be well lubricated. Some machinists wedge the tail of the dog in the faceplate to minimize any backlash

4 The shaft is now undercut so that the threading tool will not hit the edge of the taper as it completes a cut. This undercut must be at least as deep as the finished thread to give full clearance

5 Though the tool could be set to feed straight in, better threads will result if the compound is set over 30 deg. The tool then moves along the hypotenuse of a triangle, or 1.154 times the depth

6 Both the angle and width of flat on the tool are next checked by inserting it in a thread gauge. Note that it fits properly in the notch of a tool for cutting 14 threads an inch [CONTINUED]





7 The tool is then placed in the holder so that its point is at the exact center of the work. If placed either above or below this center line, it will probably cut threads having a poor finish

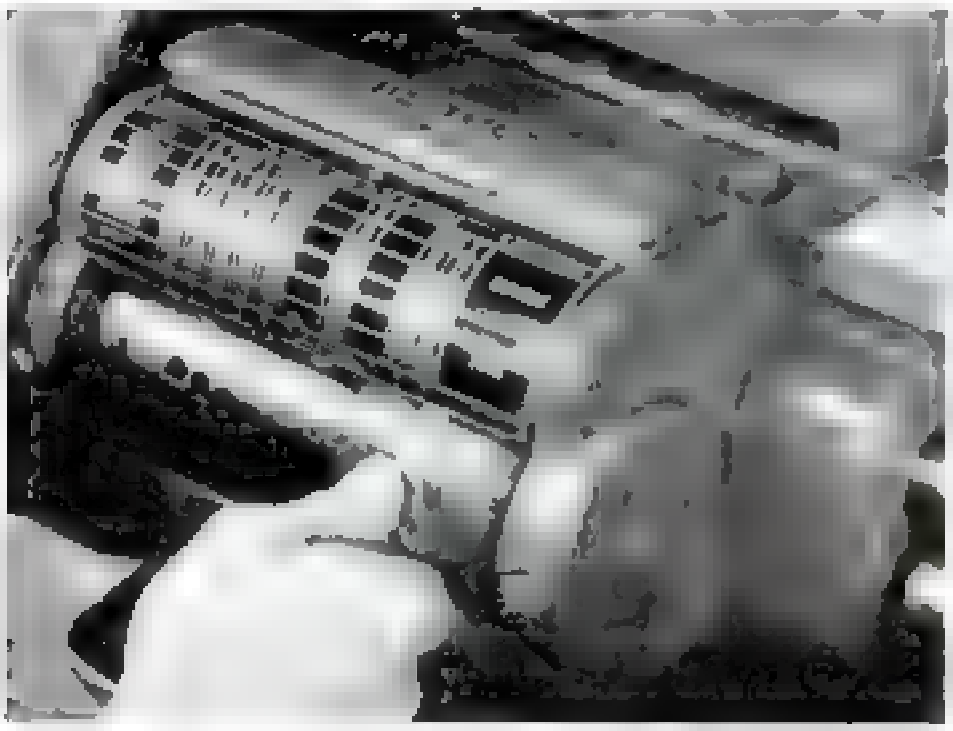
8 A center gauge is used to be sure the tool is square with the surface to be threaded. With the gauge flat against the work, the tool holder is moved until the tool fits in the 60-deg. notch

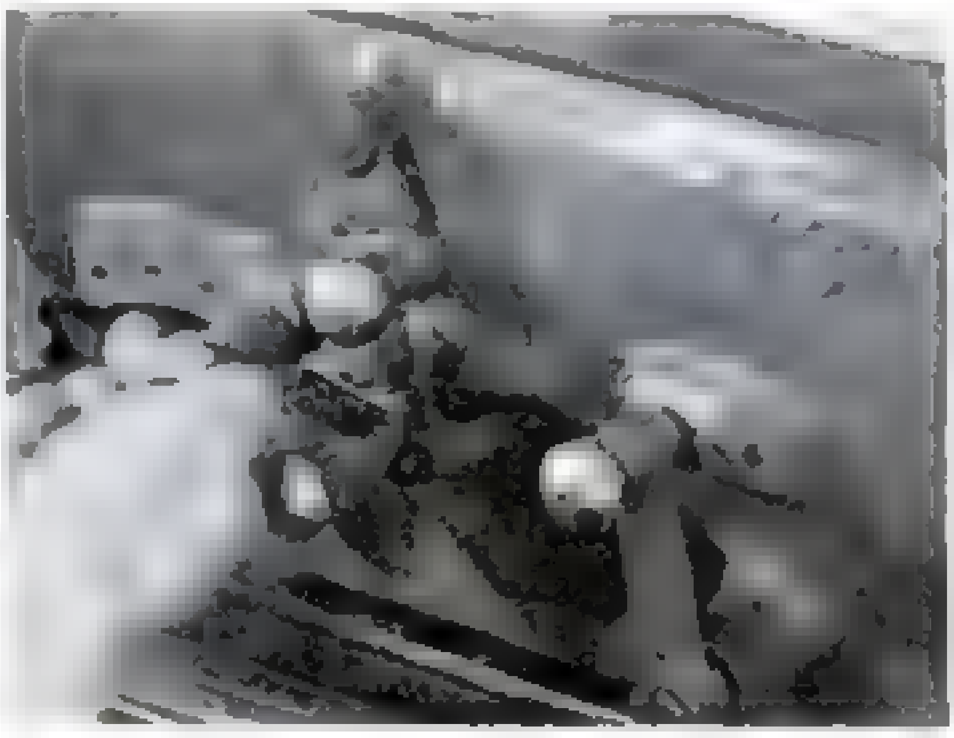
9 With the compound rest set at zero to provide a point from which to measure tool travel, the cross slide is advanced until the tool touches the work, and a stop is clamped to it at this setting

10 Since the lathe carriage is moved by the lead screw during threading, the lathe feed rod is disengaged by adjusting this lever to the neutral position. It stays untouched during the operation

11 The gearing between the lead screw and lathe spindle is set for 14 threads per inch. This means that the spindle makes 3½ turns while the lead screw, with four threads per inch, makes one

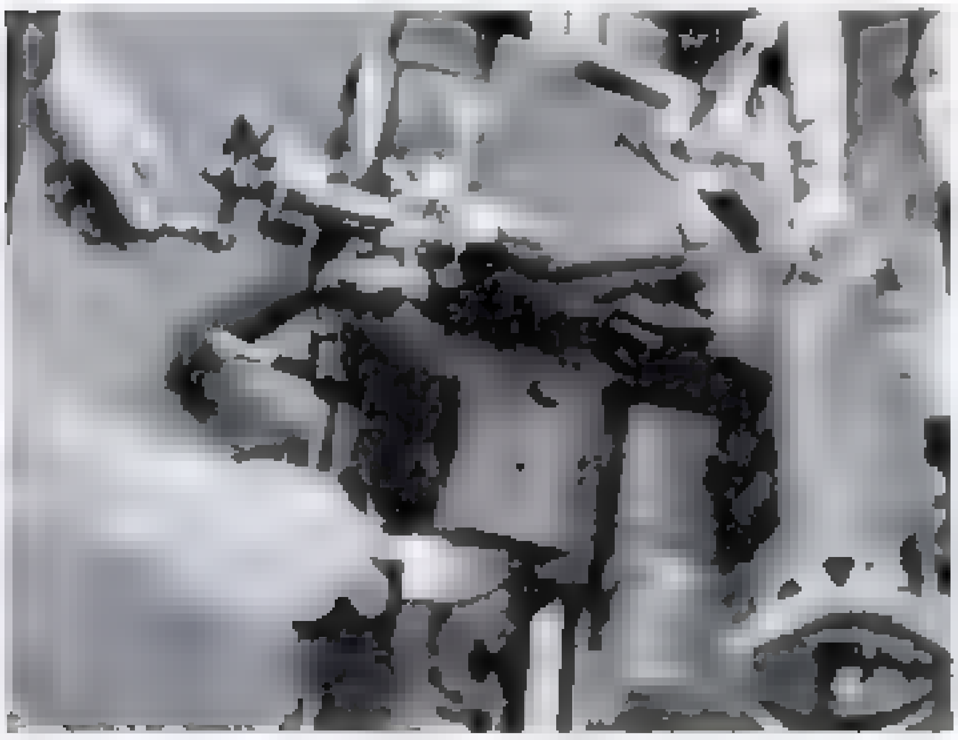
12 When the right relation has been established between spindle and lead screw, the speed of the spindle is set for the material being worked. About 20 r.p.m. is suitable for this steel shaft



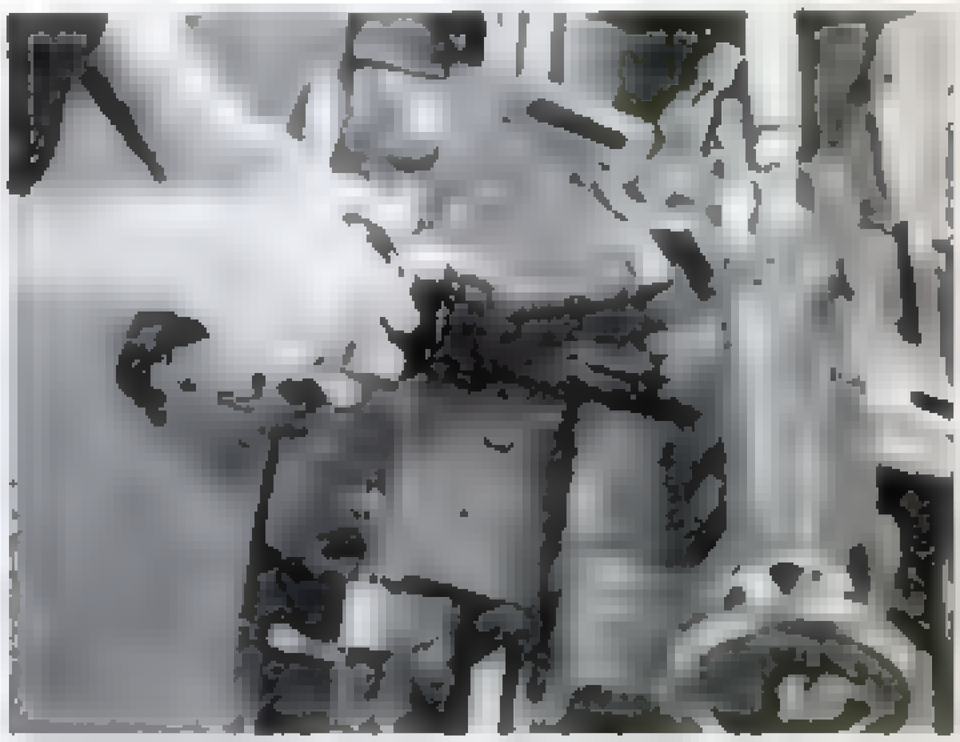


13 The carriage is engaged to the lead screw by this lever. Since the tool must always travel the same path, a threading dial is used to locate the proper place to re-engage for subsequent cuts

14 To test the setup, a light trial cut is made with the tool advanced .002" by the compound-rest feed. This will cut light lines in the work, giving an easy way to count the threads per inch



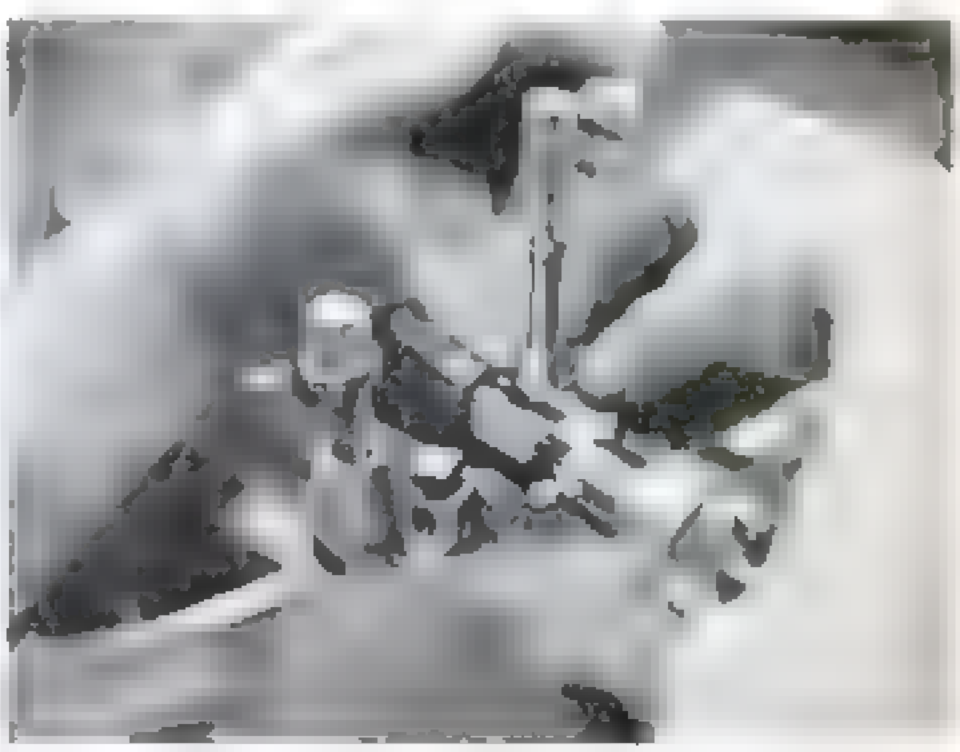
15 As soon as the tool enters the undercut the carriage is disengaged from the lead screw, and the tool is backed out by means of the cross feed. The tool goes back to the starting position



16 After the cross slide has been moved against its stop, the tool is advanced about .005" by the compound-rest feed. When the total movement of the compound rest is .054", the thread is finished

17 To get a smooth thread, a good cutting oil is used. It is also important to engage the lead screw some distance before the tool enters the cut so as to compensate for any backlash in the gears

18 As the thread nears its specified depth, it can be checked with a thread micrometer. To be sure of a fit, it is often advisable to test the thread directly on the part for which it is made



COLOR Moods for Your Photographs

HOW TO TONE BLACK-AND-WHITES TO BRING OUT SPECIAL EFFECTS

By Sigismund Blumann, F.R.P.S.

WHILE many black-and-white photographs may be things of beauty, there are many subjects that can be enhanced by color. Toning of black-and-white photographs is as interesting as it is simple. Accurate mixing of solutions, cleanliness, and chemically pure (c.p.) chemicals in sealed packages are essential to success. Use only glass, plastic, or enameled trays without chips where metal is exposed. Most toning chemicals are sensitive to light, so their solutions should be kept in dark bottles and out of daylight.

It is often forgotten that water is a chemical and is as subject to impurities as any other and more likely to be contaminated. Distilled water is not always imperative, but it assures pure water.

Except when prints are to be toned with liver of sulphur, it is imperative that all hypo be washed out of the emulsion and the paper. Not enough washing after toning is bad. Too much may be equally harmful. The blue and green of a well-toned print may deteriorate into a blackish-blue mottle and a green tone turn a sickly yellow-green when overwashed. If

Color toning in blue emphasizes this snow scene. Care must be taken to keep from staining the whites

there is a tinting of the whites, and three minutes of washing in running water or in four changes of still water does not remove the discoloration, place the print in a tray of clear water to which has been added 5 grains sodium carbonate to each ounce of water. Too much alkali will revert the print to black and white. If, on the other hand, a green or blue print calls for added brilliance after washing, it may be stepped up by a bath of 1 minim hydrochloric acid to each ounce of water.

Some developing emulsions respond more promptly to toning than others, and some brands of paper refuse to respond to the liver of sulphur process. In such a contingency, simply use another process to obtain the desired result.

For the bleach and redevelop processes, it is sometimes an advantage to have the prints slightly on the dark side as the browns produced are more translucent than the original black. Prints toned in solutions of the metal salts should be on the light side as the deposit acts toward increasing density.

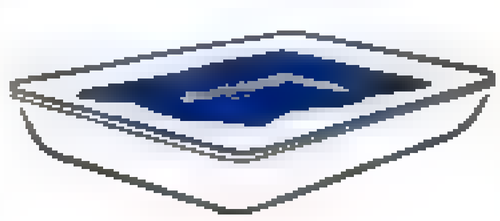
Toning with blue adds naturalness to water and sky in this view of the sea

The following formulas are for bromide, chlorobromide, and chloride prints, whether they are contacts or enlargements. Prints to be toned must have been developed, well washed, and dried. Just before toning, allow the prints to soak in clear water until they are thoroughly saturated. This will help to avoid uneven toning.

Brown Tones. The bleach and redevelop method is most common and popular. It has a definite advantage in that it changes the black silver image to a silver sulphide, thus making for greater permanence.

Bleaching solution:

Potassium ferricyanide	½ oz.
Potassium bromide	½ "
Water	4 "



Bleach the print until the deepest shadows disappear, and wash until the water shows no discoloration. Then redevelop in

Sodium sulphide	¼ oz.
Water	25 "

The image should come up in a good brown almost immediately. Remove it from the solution for a final washing of five minutes in running water or four changes of still water when toning is even and complete.

For a colder brown, soak the black-and white print in the redeveloping solution (the sulphide) a few minutes and, after a short wash in clear water, bleach and redevelop as directed.

Liver of sulphur brown toner:

Liver of sulphur	60 grains
Water	16 oz.

Add 1 minim of strong ammonia to each 4 oz. just before using

Green puts vividness in this picture of sentinels standing against the sky

Wash well, and if a rich red is desired, give it a finishing bath in

Water	10 oz.
Sodium sulphite	1 "

Finally wash the print well and dry. The color becomes richer on drying.

Blue Tones. As the image is considerably intensified by this process, work with prints that are on the light side.

Water	20 oz.
Potassium ferricyanide	90 grains
Ferric ammonium citrate	45 "
Nitric acid	10 minims

It may be necessary with some papers to increase the acid content to as high as 50 minims, but use no more than is required. Toning begins immediately and, with a fresh solution, should be complete in one minute or less though the blue may not be evident until the print has been a minute or so in the wash water. Overtoning stains whites. Washing should only be sufficient to clear the whites, and, if prolonged, may destroy the blue tone. If the image fades or spots in the toning bath, there is hypo in the emulsion on the print. If the color reverts to black in the wash water, the water is alkaline. The effects of insufficient washing out of hypo in the original fixing of the print cannot be remedied, but alkali in the water may be neutralized by adding a little acetic, nitric, or citric acid to the final wash.

An acid bath, say 15 grains oxalic acid to 16 oz. water or 5 minims nitric or hydrochloric acid to 16 oz. water, makes the blue more vivid and, with some brands of paper, somewhat alters the tone. In every case the image is intensified.

Green Tones. Vanadium is preeminently good for green toning baths, but is sometimes difficult to obtain. However, a commercial green toner will give reliable results. Here is an accepted formula using vanadium:

Toning takes place in from three to ten minutes according to the temperature of the bath. Sometimes the brown is not apparent until the print has been washed and dried. With some emulsions, it may be necessary to add 2 grains hypo crystals to each ounce of the solution. The color is a rich photo brown having the characteristic purplish tone of gold-toned albumen papers.

Red Tones. Solution A:

Water	9 oz.
Copper sulphate	55 grains
Potassium citrate	50 "

Solution B:

Water	1 oz.
Potassium ferricyanide	45 grains

Pour B into A slowly, stirring constantly. In this solution, the print will tone from purple brown through shades of brown to a good red. Remove the print when the desired color is reached and clear it in

Water	16 oz.
Nitric acid	1 dram

Solution A:

Ferric chloride 10 grains
Oxalic acid (concentrated solution) .... 1 oz. 4 drams
Vanadium chloride .... 20 grains
Water .... 5 oz.

Solution B:

Potassium ferricyanide .... 50 grains
Water .... 5 oz.

Slowly, and with constant, gentle stirring, pour A into B, never the reverse. If toning does not begin the moment the paper is well under the combined bath, the emulsion of the print requires the addition of from five to as much as 50 grains of potassium ferricyanide. In such a contingency, simply put the print into clear water, add the needed ingredient to the bath and see that it is completely dissolved, then replace the print in the toner bath again. Prolonged toning makes for a disagreeable yellowish color. The full richness of the green appears in the wash water, but too much washing causes the print to become bluer and bluer until, finally, the green is lost.

For particular results, after having washed the green-toned print, you can clear the highlights and improve the color by immersing the print a few minutes in the following bath:

Water .... 16 oz.
Borax .... 320 grains
Hypo .... 8 oz.

Multiple formula. Solution A:

Water .... 3½ oz.
Uranium nitrate or acetate .... 20 grains
Acetic acid (glacial) .... ⅓ oz.

Solution B:

Water .... 3½ oz.
Potassium ferricyanide........ 20 grains
Acetic acid (glacial) .... ⅓ oz.

Solution C:

Water .... 3½ oz.
Citrate of iron and ammonia.. 20 grains
Acetic acid (glacial) .... ⅓ oz.

The citrate of iron and ammonia may be the brown scales or the green, but they must be crisp and shiny. Insist on unopened bottles of known brands. Dissolve each solution in the order given, and keep in chemically clean, dark-colored bottles with good stoppers.

The least trace of hypo in prints may lead to fading, spots, and other trouble. Wash the prints before toning. Then use

Blue: B, 1 part, C, 1½ parts.
Green: A, B, and C, each 1 part.
Sepia: A, 2 parts, B, 1 part.
Red: A and B, 1 part each

Wash the toned print in four changes of still water, allowing two minutes to each change of water, then fix and clear in

Acetic acid (glacial) .... 20 minims
Water (tap will do) .... 20 oz.

Wash in still water. Vivify the color in

Potassium alum .... ½ oz.
Water (tap water will do)........ 25 "

Wash again in four changes of still water. Still water is specified as the delicate deposit of metallic pigment would be washed off by running water. Wherever uranium is involved, the minutest trace of alkali in the water will remove the color and cause a reversion to black and white. This is useful when a toned print is to be restored to its original color. Combination of the various solutions in different proportions in the multiple formula is possible for nuances.

Sun through leaves and green tints give the woods scene added beauty

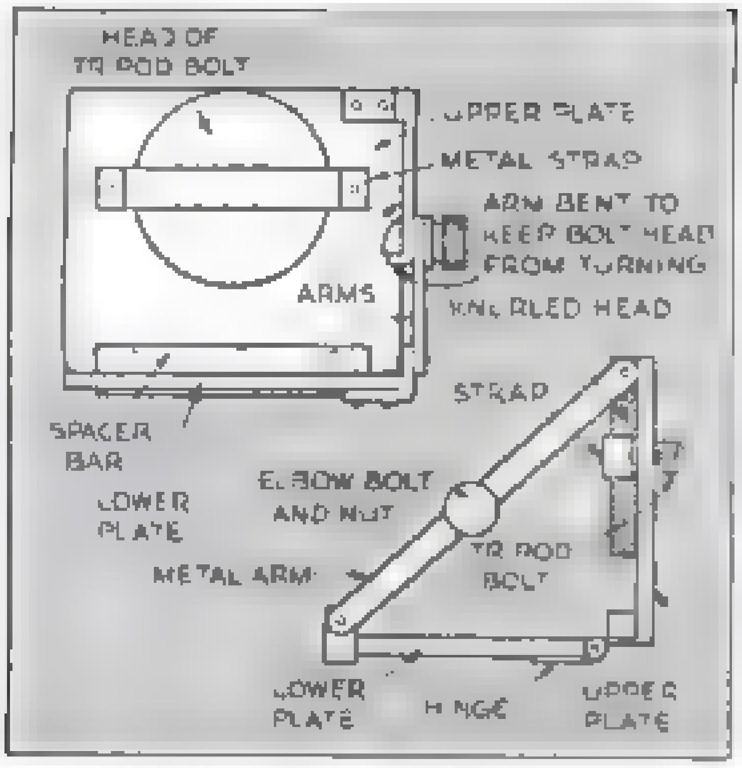
CUTOUTS placed in front of photographic or prop backgrounds afford many possibilities for striking pictures. As shown at the right, the finished photograph is made by cutting out and mounting a selected subject before an appropriate background, and then photographing the two units together.

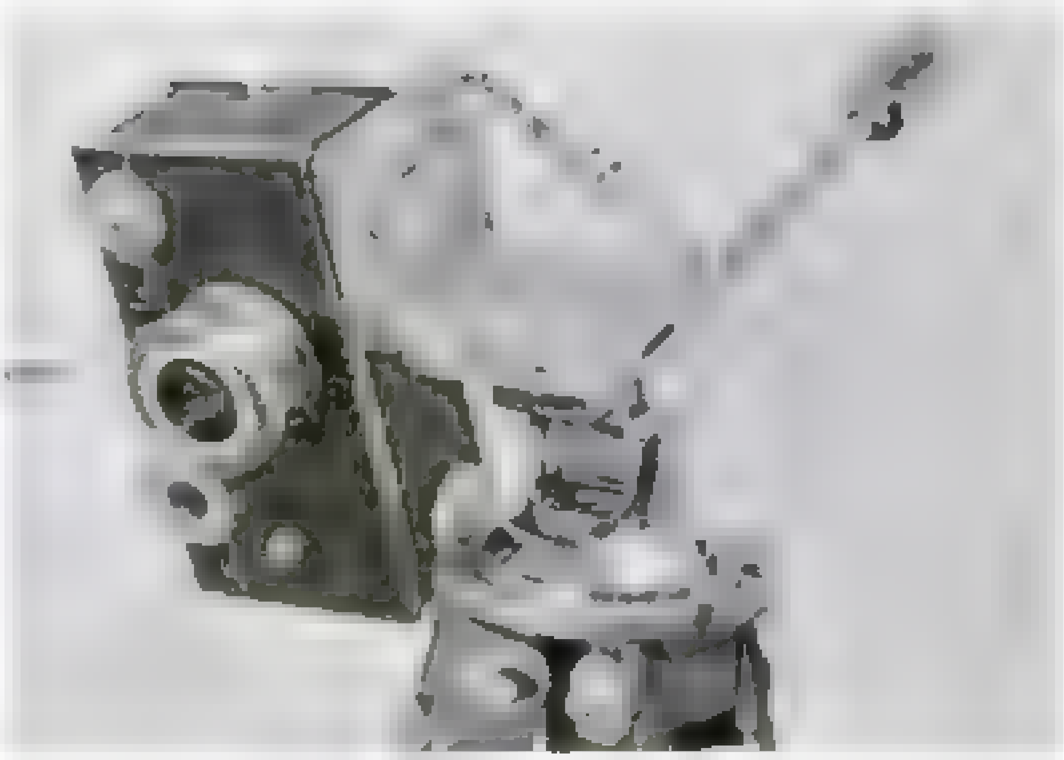
The cutout, preferably on double-weight paper, should be carefully trimmed to follow the exact lines of the subject. To prevent any white fringes from showing, blacken the edges with ink. Provide a stand by gluing a flap of fairly stiff cardboard to the back of the cutout. If the cutout is over-flexible or shows a tendency to curl, reinforce it by gluing strips of cardboard along the back.

Next, tack up the background picture and pose the cutout in front of it. In lighting, decide whether you wish a shadow of the cutout to appear on the background; it may or may not be desirable. Also decide whether the background should be precisely in focus or whether it should be subdued by being somewhat out of focus. You will find in general that landscapes, seascapes, and cloud masses will be your most useful backgrounds.

Used with imagination, this process affords wide scope for dramatic pictures. Props may be used for backgrounds instead of photographs, as in the flag shot at the right. There are also many opportunities for the effective use of table-top settings and symbolic backgrounds such as newspaper headlines, posters, or magazine covers.—LOUIS HOCHMAN.

SCARCITY OF CUT FILM need not hamper photographers who can still obtain roll film of suitable width. A print trimmer, fitted with a wire support for the film spool, and equipped with two pins or brads to locate the proper film length in the dark, provides a satisfactory way to convert roll film into cut film. To avoid objectionable finger marks, it is best to cut the film before removing the paper backing or leader. The difference in thickness between cut and roll film does not appear to cause any difficulty in focusing.—ROBERT F. BENENATI.

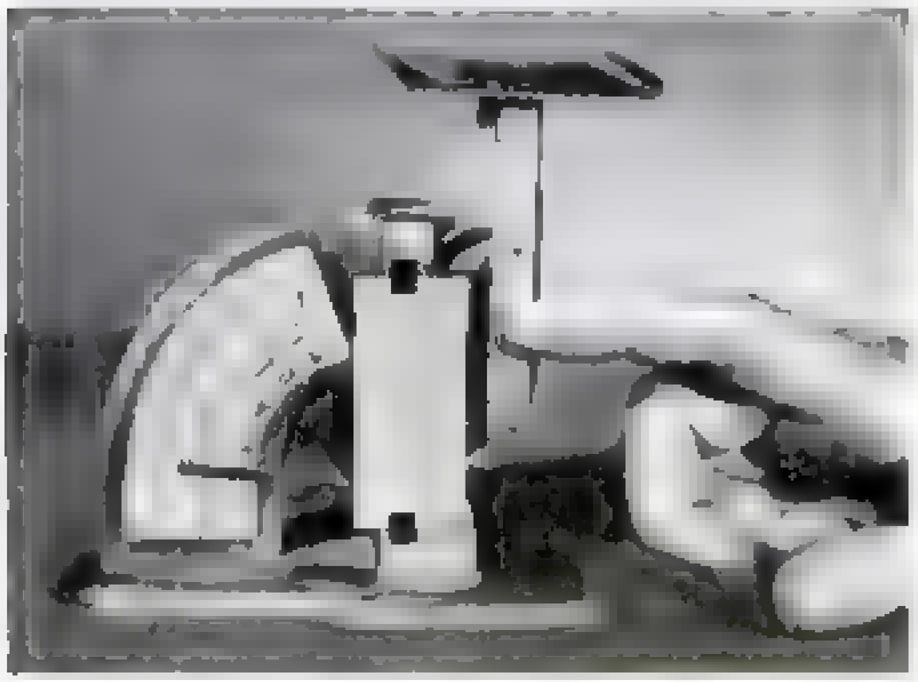




A TILTING TRIPOD TOP for use with cameras which have only one tripod socket will make it easy to take vertical as well as horizontal pictures. This accessory, which is both compact and steady, can be built without difficulty from scrap metal.

The top consists of two metal plates, spaced apart by a bar which is riveted to the upper plate. This bar should be thick enough to allow room between the plates for the camera-socket bolt and for the thin strap that holds it in place. The two plates are hinged together, one leaf of the hinge being riveted to the lower plate and the other to the spacer bar.

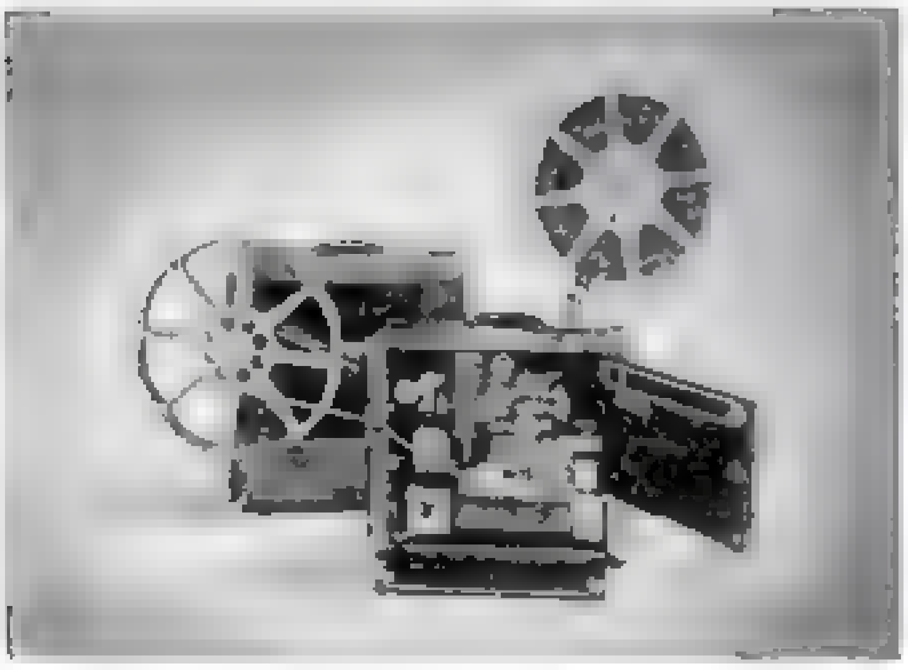
A small metal arm with a bolt and knurled nut at its elbow locks the two plates in position. To keep this little bolt from turning, a flat face is filed on the side of its head and one end of the arm is bent up to bear against this surface. Each end of the arm is riveted loosely to a pair of small brackets which are themselves firmly riveted to the two plates. A piece of felt should be glued to the top of the upper plate to add friction and to protect the camera.—C. B.



IN WEIGHING CHEMICALS for photographic solutions, an ordinary postage scale will be found to be sufficiently accurate. For simplicity, attach a table to the scale which shows equivalents between ounces and grams. This table, which can be clipped or copied from any photographic almanac, must of course be placed on some stationary part of the scale where it will not interfere with normal operation or reading. The scale can then be used interchangeably either for weighing mail or for preparing photographic solutions.—JOHN K. KARLOVIC.

THE TEMPERATURE OF WATER used to wash negatives or prints may be read at a glance if a thermometer is installed on a darkroom faucet. A ½" pipe tee, a valve, a thermometer, and a brass plug are the principal parts needed. This brass plug is screwed into the upper tee opening, and the thermometer, seated in a bit of cotton, rests in a hole drilled almost through the plug. A cork or rubber plug may also be used, if the thermometer extends through the hole. The valve is used to connect the tee with the water pipe, while a bathtub hose connector may be screwed into the lower tee opening.

Protect the instrument by slipping a tubular shield over the thermometer and onto a projecting shoulder of the plug. The shield shown at the right was originally a clip used for closing the open end of a vacuum-cleaner bag.—W. E. B.

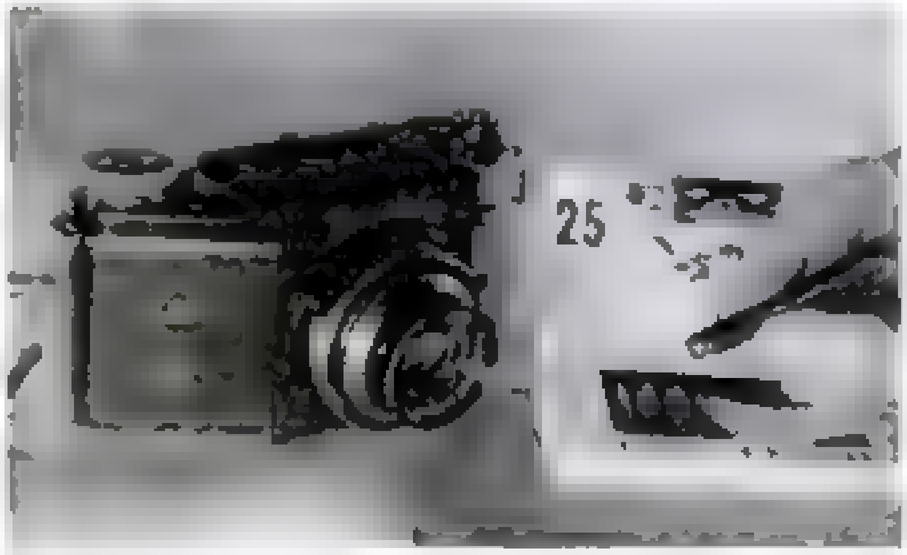


FEW CRITICAL MATERIALS go into the construction of this new 16-mm. sound-on-film projector. Die castings, made of aluminum in former projectors, are now zinc. A sound head of welded sheet steel has been substituted for the casting previously employed. The makers assert that although the projector and case are slightly heavier than comparable past models, improvements in design make it superior to prewar machines. As an example, they cite a new type of gear-case ventilation which prevents the formation of oil film on optical components. Present production goes to the armed forces.

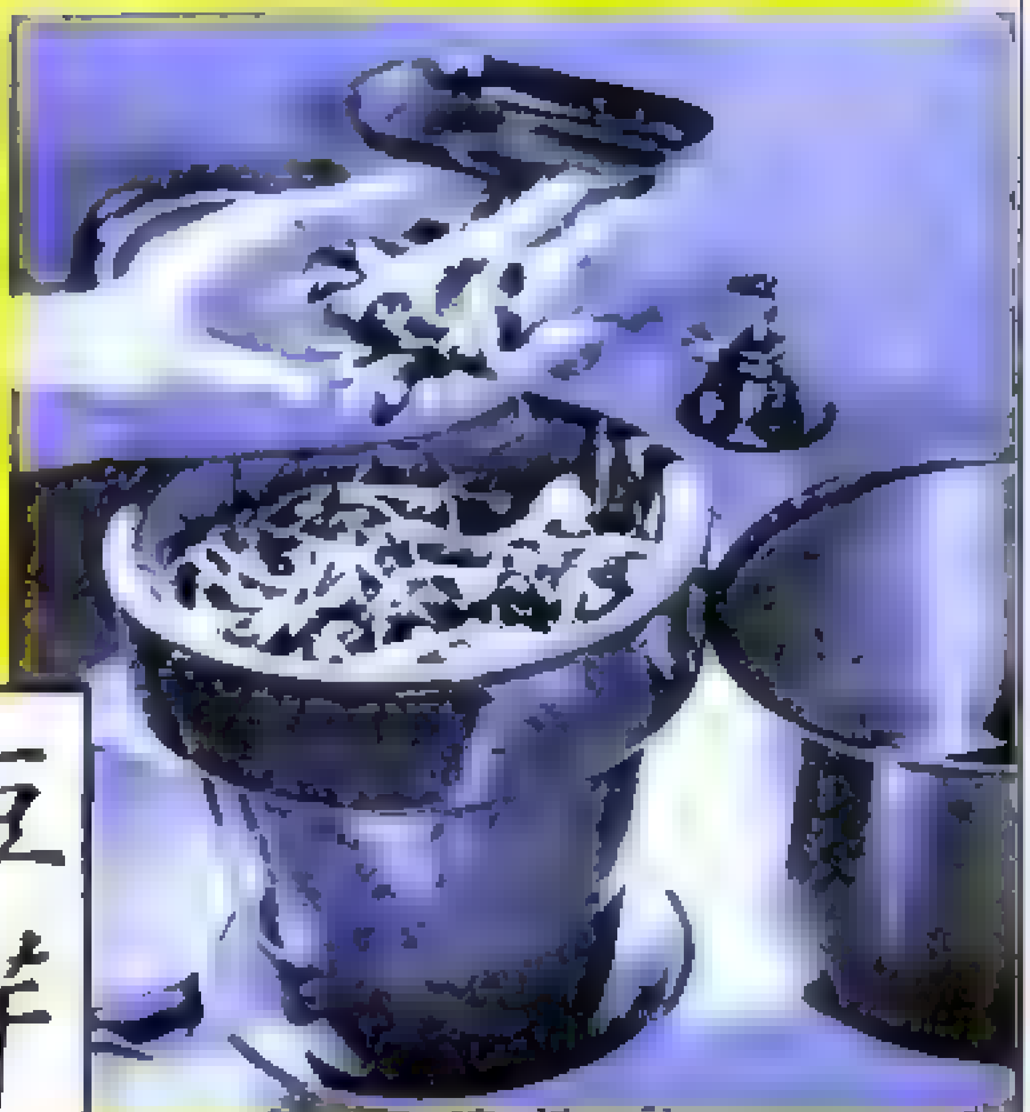
SCRATCH-FREE CLEANING of valuable camera lenses is said to be possible with this pencil-type glass cleaner. Especially made for use on optical glass, which is relatively easy to scratch, the pencil is used to draw a few circular marks on the lens, after which the lens is polished with a soft, lintless cloth. Included among the advantages listed for this method are safety, speed, and convenience, as well as the fact that no greasy sheen remains after cleaning. The lens pencil can also be used on eyeglasses, microscopes, and other optical devices.

FOR COPYING, a wooden tilt top of the kind used with view cameras serves almost as well as a regular copying stand. The written, printed, or photographic material to be copied is thumbtacked to or held by elastics against the upper half of the tilt top, which in turn is locked in the 90-deg. position. Copying can then be done with the camera placed horizontally, thus avoiding the problems of camera support involved in vertical copying. If the material to be copied is too large for the tilt top, a piece of stiff cardboard placed behind it will afford the necessary rigidity.—J. K. K.

ANILINE DYES which are absorbed by photographic gelatin are contained in this new retouching kit. The dye solutions, which are brushed on and which may be used on either negatives or prints, are said to produce smooth, even-toned effects. Fine-line work that is practically indistinguishable from lines on an unretouched negative may also be performed. Three shades of the dye solution are supplied in the kit, together with bottles of reducer, masking fluid, and a liquid said to give smooth control of dye flow. Also included are blotters, cotton-swab sticks, a brush, and a dropper. The simple procedures involved make the kit suited for amateur retouchers.



Victory Garden in a flowerpot



豆芽菜

Stages in the growth of the sprout, from its first appearance to the point where it is just right to be cooked, are shown at the top of the page. Just above is a crop of sprouts ready for a tasty recipe

SOYBEANS, now cultivated extensively in this country, are becoming almost as familiar to the American housewife as they are to the Chinese who have made them an important part of their diet for 5,000 years. In addition to having wide use as an ingredient for industrial products and as both fodder and fertilizer on farms, soybeans are common on many dining tables in a variety of dishes.

One way of using this versatile bean as a food, however, probably isn't so well known. Sprouting converts the dried bean into a fresh vegetable that not only rivals tomatoes in vitamin C, but contains healthy amounts of protein, calcium, iron, thiamine, niacin, and riboflavin, which are found in beefsteak.

Protein and calcium, builders respectively of muscle and bone, acquire an added significance in a time of rationed meat, cheese, and other dairy products. Thiamine, riboflavin, and niacin are the principal constituents of vitamin-B complex, the vitamin so essential to health. Thiamine, derived chiefly from whole cereals, is necessary for the normal functioning of the nervous system. Riboflavin, found largely in meat, eggs, and leafy vegetables, promotes growth and helps increase the span of life. Niacin, supplied by meat, milk, and greens, guards against nervous and skin disorders.

Dr. Clive McCay and his nutrition staff at the New York State College of Agriculture, Cornell University, have developed a simple method of sprouting that can be followed by the housewife in her own kitchen.

Any wide-mouthed receptacle can be used for sprouting beans at home, provided it has a hole in the bottom for water to drain through. A housewife will probably find an ordinary clay flowerpot best suited for the raising of a small crop of sprouts for a tryout in some of the appealing new dishes. A coat of some bright, Chinese color will transform such a pot into an ornamental as well as a functional adjunct, and above are some Chinese characters that will carry the Oriental motif a step further if they are reproduced on the pot. They mean "bean-sprout vegetable."

Dry soybeans for successful sprouting need possess no higher quality than a mere ability to grow, and they are pretty sure to do so if they are less than a year old. The more expensive, higher-grade beans are not necessary. Field beans generally used as fodder are good enough if they are free from other seeds, and a half pound of them will return an abundant family supply of sprouts in from three to five days.

Aside from the pot and the beans, and water, the process calls for nothing except a little chlorinated lime. Dilute solutions of the lime are used to prevent mold.

Rules for sprouting are simple. Inspect

and wash a half pound of beans and soak them overnight in 1½ pints of water to which has been added a pinch of the chlorinated lime. After soaking, the beans should be strained and poured into a sprouting pot large enough to hold them, as they swell to twice their original size. A piece of wire screening over the hole in the bottom of the pot will keep any beans from falling through and scattering when the pot is moved about.

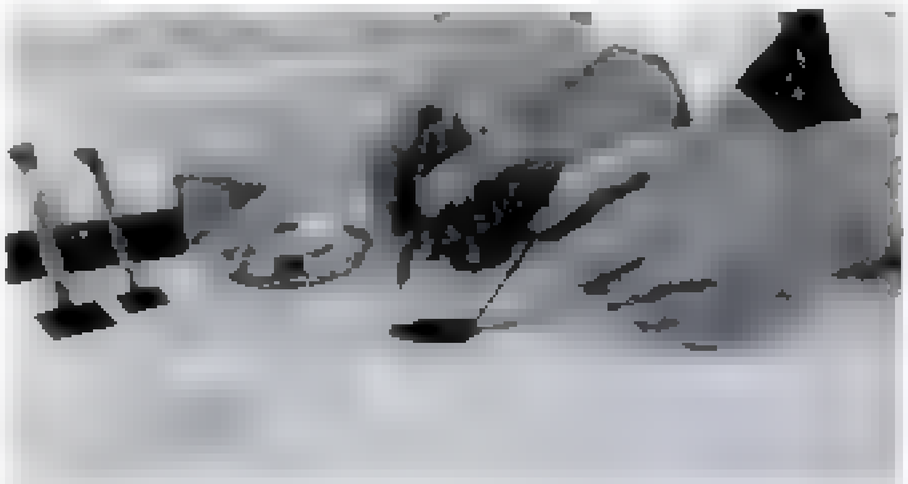
At the left, a small sieve is being inserted to keep the beans from dropping out of the sprouting-pot hole. A watering can is a handy sprinkler to use for the frequent wetting of the sprouts, while at the right the pot is being covered with a fitted top to keep out all daylight

Now cover the beans with a wet cloth and also place on top of the pot a piece of wet cardboard or a plate to keep light out. Sprinkle the beans with plain water three or four times a day, taking care after each sprinkling to joggle the pot so that all excess water will drain out the hole. A last sprinkling each night should be made with a solution formed by dissolving 1/8 teaspoon chlorinated lime in 1 gal. water as a guard against the formation of mold.

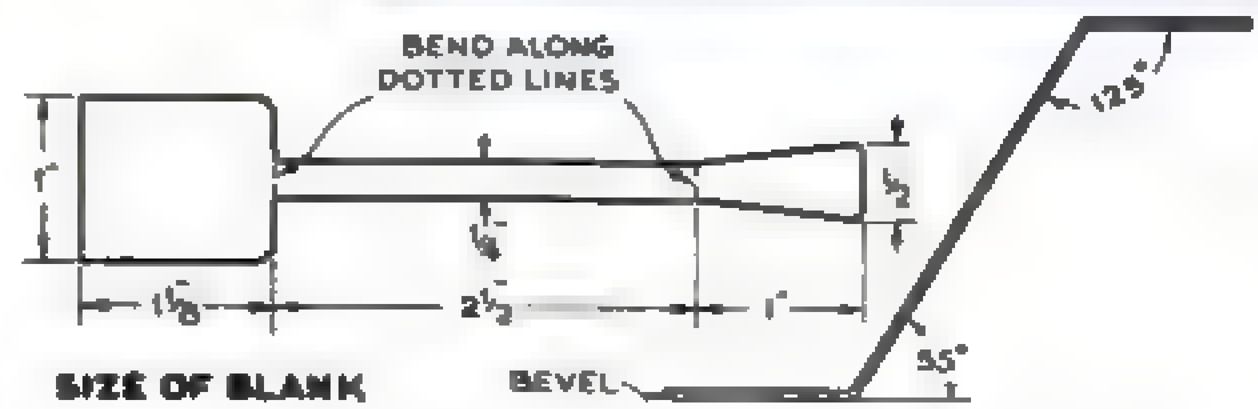
Sprouts are fully grown when they are about 1¼" long. They grow faster in warm weather than in cool, but they seldom take more than five days to mature. In very hot weather, mold may develop despite the chlorine treatment, but ice cubes placed on top of the wet cloth will help to avert it.

Section Lifter Aids Microscopists in Handling Specimens

SPECIMENS prepared for microscopic examination are often so delicate that they may be damaged even by gentle handling with forceps. However, it is easy to make a section lifter, a simple little instrument which is used shovel-fashion and which will transfer specimens without harm onto a glass slide or from solution to solution.



A section lifter may be cut from a sheet of 24-gauge copper, using the dimensions shown in the drawing at the right. After a blank has been cut, remove any burrs from it and file a bevel on the forward edge of the lifting surface. Then bend the piece to shape, and finish by cleaning thoroughly with a piece of fine emery cloth.—H. F. WHITTAKER



COPPER... *the ageless metal*

Used Since the Dawn of History, It Has Properties That Make It Proof Against the Ravage of Time

By KENNETH M. SWEZEY

OF ALL the metallic elements, copper was probably the first used by man. Objects fashioned from copper date back long before recorded history. This reddish, soft, long-lasting metal still plays a principal part in the industry of the world, for iron is the only metal produced in greater quantities.

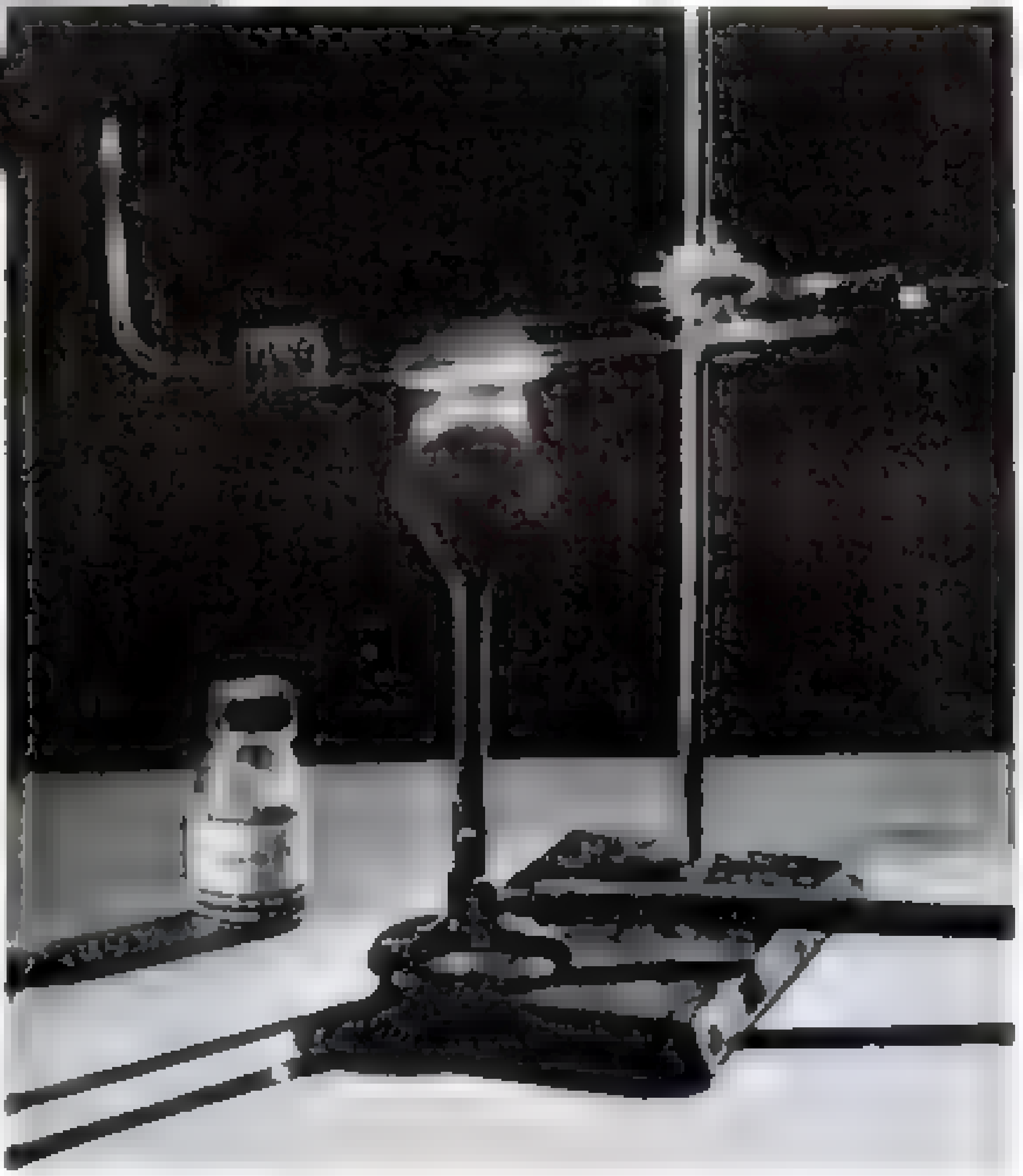
Copper is valued chiefly for three properties: it has much higher electrical and heat conductivity than any other common metal, and it is remarkably resistant to corrosion. Coins, ornaments, and tools made of copper and its alloys, brass and bronze, have weathered centuries. Its heat conductivity makes is a highly efficient material for radiators. The great electrical conductivity of copper, its strength, and its ductility, make it ideal for wire and other conductors.

Dry air does not affect copper at all. Exposed to moist air, the surface of copper first changes to red or black copper oxide. This in turn is changed to a green basic carbonate that resists all further corrosion. Scratch away a little of this carbonate from weathered copper, and you will discover the bright metal unharmed beneath.

Copper carbonate can be used as the basis for a whole series of copper compounds. Dissolve the green chemical in an excess of a dilute solution of an acid, and a solution of the corresponding salt will be formed. Dilute nitric acid produces copper nitrate, hydrochloric acid makes copper chloride,

A Bunsen flame rich in chlorine is obtained by fastening cotton, wet with carbon tetrachloride, to the air intake of a burner. The flame burns blue-green as copper wire held in it turns to copper chloride, but pure copper forms again on a clay pipe held above

Copper wins easily in the "heat race" shown at the left, while in the setup below copper oxide is being changed back to copper metal by heating it in the presence of illuminating gas rich in the hydrogen needed for the reaction. At the bottom of the page a solution of copper sulphate is undergoing a transformation as the iron of the nail changes places with the copper



and so on. The salt can be obtained by evaporating the solution

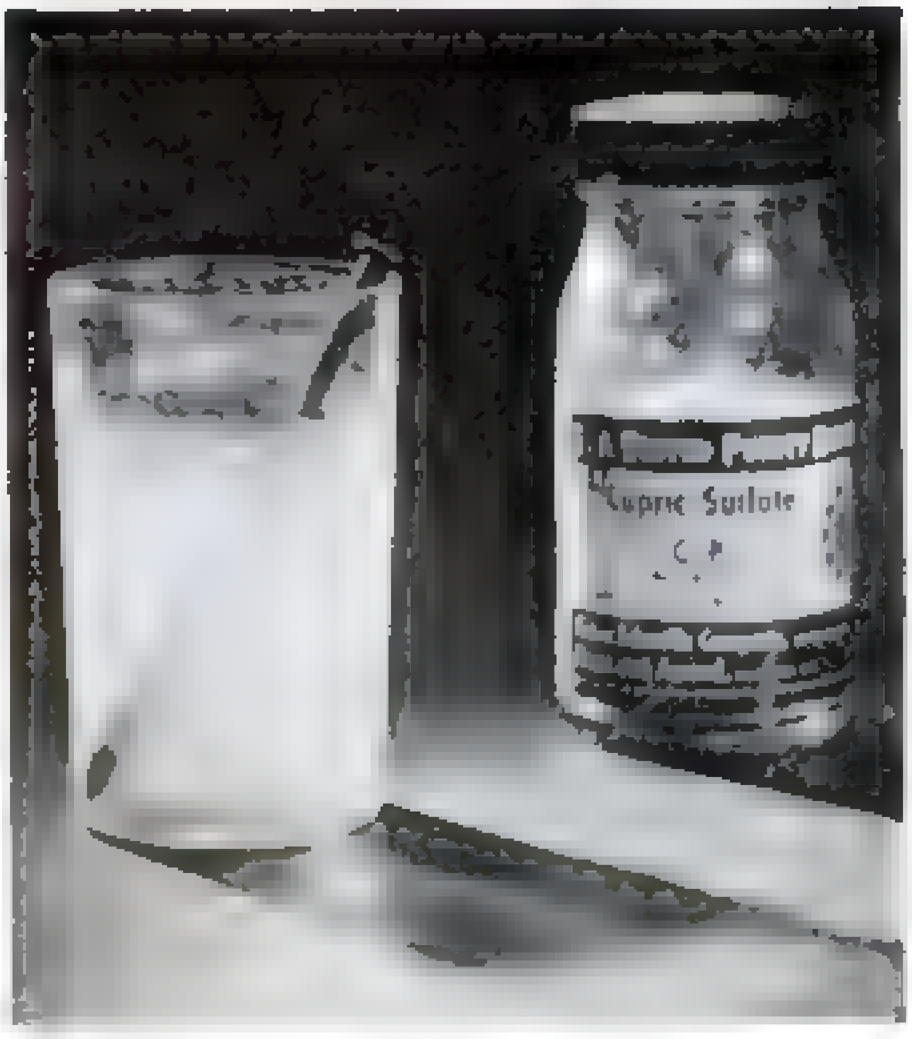
You can make copper carbonate in your home lab by simply adding a solution of sodium carbonate or bicarbonate to a solution of any soluble copper salt, such as copper sulphate. The green carbonate will precipitate out

As a heat conductor, the superiority of copper over other common metals may be shown by a simple conduction race. Slice up a small candle and put a piece on the end of a 6" length of bare copper wire and similar lengths of iron, aluminum, and other wires. Attach these, as illustrated, by heating the end of each wire and allowing it to melt its way into a slice to a depth of the thickness of the wire. Then mount the wires with their free ends close together and with the ends holding the candle slices fanned out. Now hold a lighted match under the free ends and watch the race. Heat will travel to the far end of the copper wire, causing the wax to melt and its slice of candle to fall off, much faster than through any other metal except silver. In a three-way race, aluminum would come second, with iron far behind.

Copper heated in a hot flame becomes coated with black copper oxide. This chemical may be obtained in quantity for your experiments by heating some of your copper carbonate.

That nothing is lost when copper oxidizes, but that something has been gained, can be proved by changing oxide back to copper. When the oxide is heated in the presence of hydrogen, the hydrogen combines with the oxygen of the oxide to form water and leave glistening copper.

Apparatus for this experiment is shown in an accompanying photo. A little pow-



dered copper oxide is placed in a hard-glass tube about 8" long. A one-hole stopper, with a bent glass tube having a jet drawn on its free end, is inserted in one end of the tube containing the oxide. The other end is fitted with a similar stopper having through it a straight glass tube which should be connected to an illuminating gas outlet. This type of gas is rich in hydrogen. Mount this apparatus on a stand with the jet end a trifle lower than the other.

After all joints are tight, turn on the gas and let it flow until all the air is swept from the tubing. This prevents a slight explosion that might jar the apparatus apart if the gas is ignited while mixed with air. Light the gas at the jet and adjust it to a 1" flame.

Now light a Bunsen burner equipped with a wing top, and heat the tube under the copper oxide gently at first and then more strongly. Soon the black oxide in the tube will change into red copper and drops of water will accumulate at the lower end of the tube. When all the oxide has changed to copper, extinguish the Bunsen flame, but allow the gas in the glass tube to flow until the tube has cooled, thus excluding air which might cause a slight explosion.

The white powder of dry copper sulphate will turn into blue crystals if wet by a solution containing any trace of water

Copper sulphate, or blue vitriol, is probably the most useful copper compound. It is employed in wet batteries, in refining copper, and in electroplating. Mixed with slaked lime, it forms the gardener's Bordeaux mixture.

Put an iron nail in a solution of copper sulphate, and within a few minutes the blue characteristic of the cupric ion begins to change to green, while the nail takes on a muddy coating of copper. Left overnight, the solution will change to a light green and particles of copper will cling to the nail or lie at the bottom.

What has happened? Iron from the nail has joined with the sulphate part of the solution, forcing the copper out. You started with copper sulphate and metallic iron, and wound up with iron sulphate and metallic copper.

Ordinary copper sulphate crystals are blue because they contain water of crystallization. Drive this water out with heat, and the crystals will fall into a white powder. Add water to the powder and the crystals will become blue again. Because of this propensity, dry copper sulphate can be used to detect water in organic liquids such as alcohol. Dry copper sulphate treated with a few drops of absolute alcohol will remain white, but alcohol containing even the slightest amount of water makes it blue.

Another important use of copper sulphate is in Fehling's solution, which is used for the detection of "reducing" sugars in food and in the blood. This solution is made in two parts. Dissolve 8¼ grams copper sulphate in water and dilute to 125 ml., and also dissolve 43 grams potassium sodium tartrate and 12½ grams sodium hydroxide in water and dilute to 125 ml. Keep them separate until ready for use.

A yellow precipitate is formed when a few drops of a solution of a reducing sugar (maltose or glucose) are added to mixed parts of Fehling's solution. Heating turns the precipitate red.

Ordinary sugar causes no reaction. Normally copper sulphate reacts immediately with sodium hydroxide to form a blue precipitate of copper hydroxide, but the tartrate ion in ordinary sugar forms a complex with the cupric ion, preventing the reaction. When reducing sugars are added, they reduce the cupric ions to cuprous ions which, not forming the tartrate complex, immediately unite with the sodium hydroxide to form a yellow precipitate of cuprous hydroxide. Heating changes this to red cuprous oxide.

HOMEMADE

FLEXIBLE LENS

SHOWS HOW LIGHT IS BENT

By BENJAMIN TAPLITZ

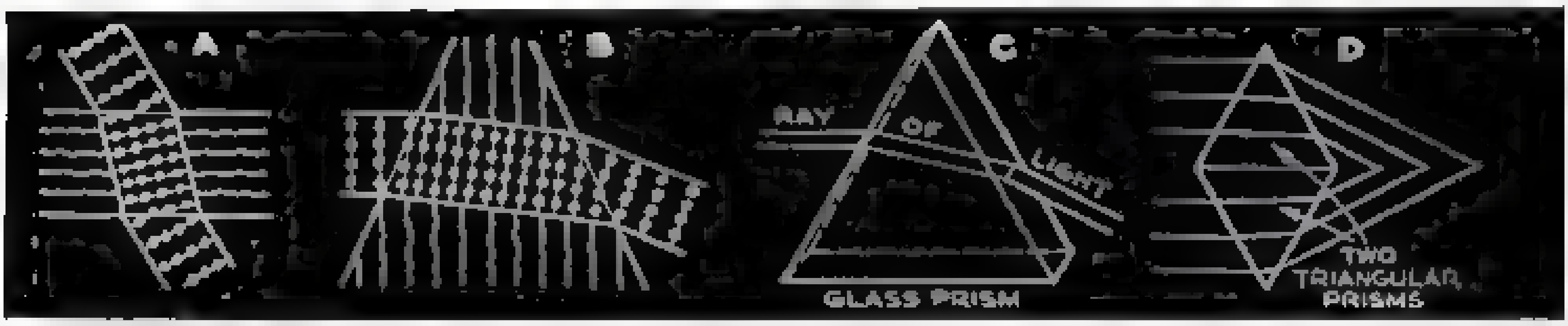
Modifying the height of the funnel, above, changes water pressure and hence the lens shape. A mirror is needed (below), since the lens must be horizontal

WHAT happens when light passes through a lens? How can a human eye see sharp images of both near and distant objects, while a camera lens must usually be focused for distance?

A unique flexible lens that you can build at home reveals the answers. Though not of good optical quality, this lens has an adjustable focal length which helps show how a lens refracts (bends) light and how a human eye differs from a camera lens. Consisting of a glass disk covered on one side by a transparent rubber sheet, the lens has a curvature which varies with the amount of water inside it.

Procure a 3" disk of plate glass and drill a small hole through it near the edge. One way to drill this hole is to break the tip from a triangular file and chuck the other end in a hand drill. The glass should be placed in a saucer of water during drilling. Break off further bits of the file as the cutting edges become dull. When the hole is completed, cement a 1" length of glass tubing in it and place around the disk a rubber band 1/2" wide cut from an old bicycle inner tube. Then stretch a piece of thin latex (a 4" square from a light-colored toy balloon will do) over the disk and hold it in position with another rubber band. For the main source of light, use either a small spotlight or a 60-watt bulb mounted in a tin can. An auto-headlight bulb, also mounted in a can, serves as a secondary light source.

By placing the lens, light, and mirror as shown on the facing page, you can project on a screen a focused image of letters printed on tracing paper and laid on top of the light source. If the screen is then moved farther away, the image becomes a



blur, but when you lower the funnel and thus reduce the curvature of the lens, its focal length is increased and the image is once more sharply defined. A refinement of this experiment is to use the second light to project a profile shadow of the flexible lens on another screen. A substantially magnified shadow will give you a ready index of slight changes in lens curvature.

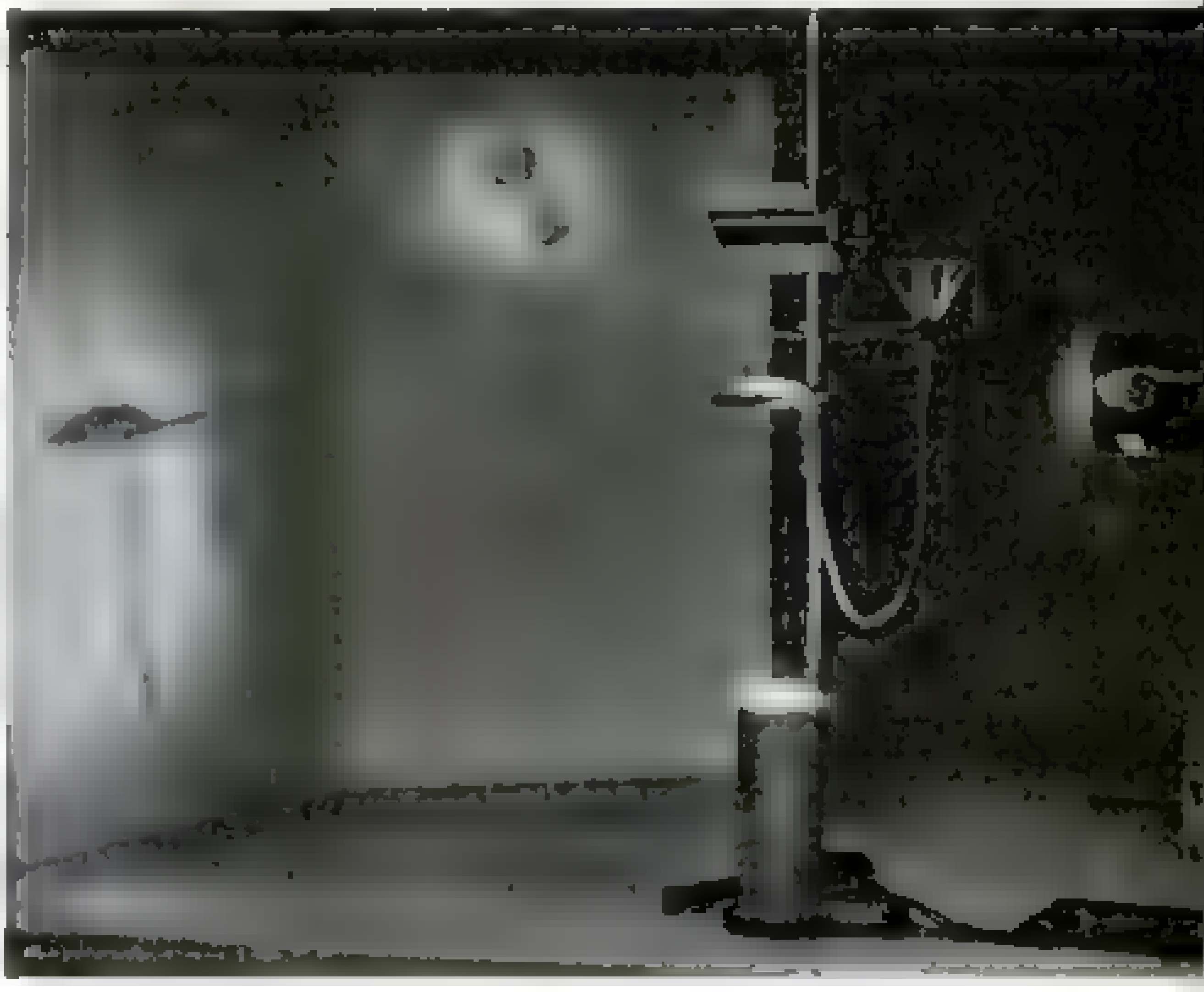
The function of any lens, of course, is to change the direction of light passing through it. Light moves in straight lines through transparent substances of uniform density, but when it passes from one substance to another, its speed and direction may change.

One way to understand why changed velocity can mean changed direction is to visualize a column of soldiers marching four abreast. If they are marching on firm ground and obliquely strike a plowed field, as in the drawing *A*, their direction of march will be bent somewhat away from its original line. The reason, of course, is that each man in each row of four is slowed down at a different time by the rough ground. Where the column regains smooth ground, its line of march is again modified as each soldier resumes the original pace.

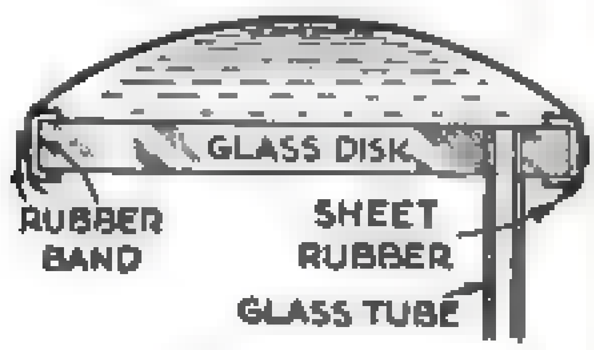
Drawings *B* and *C* suggest how, if the column moves through a triangular patch of rough ground as a beam of light passes through a prism, direction is changed twice, once at the point of entering the patch and once at the point of leaving. In *D* it will be seen that light passing through a pair of equilateral prisms fails to meet at a single point. But if a number of prisms of the proper shape are used *(E)*, the emergent rays do meet at a single point or focus. In practice, if two curved surfaces are used instead of a number of prism planes, the resultant convex lens will accommodate the maximum entering and emerging rays.

The focal length of a lens is the distance from its optical center to the point where originally parallel rays are brought to a focus. Drawings *F* and *G* show how the shape of a lens determines focal length. With a thick lens, each ray enters and leaves at a greater angle than with a thin lens, which means that the rays are bent more and that the focal length is therefore shorter.

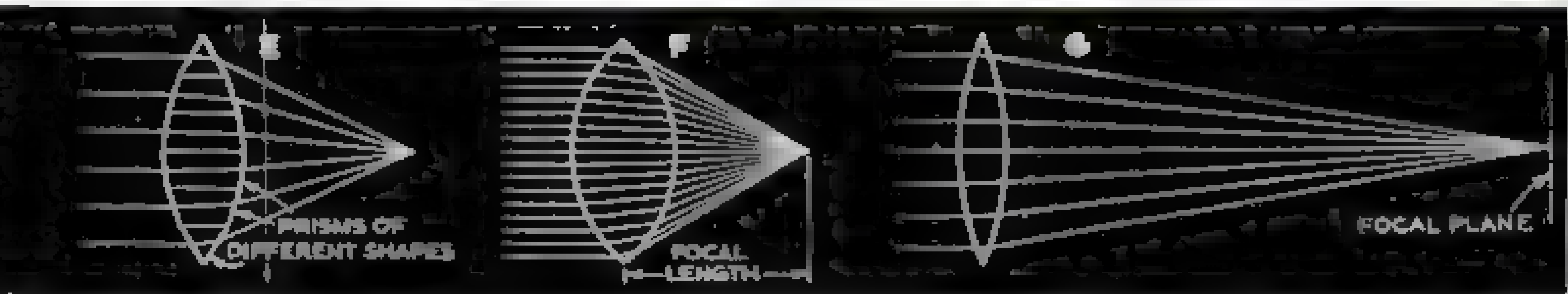
In one way, our flexible lens is similar to the human eye and different from a camera lens. A camera lens is usually focused by moving it nearer to or farther away from the film; in the eye, the distance between lens and retina remains constant, while the focal length of the lens is changed. Tiny muscles increase or relax pressure on the flexible lens in a human eye and so modify its focal length.



The completed setup is shown at the right. Note the lens shadow



A thin rubber or latex diaphragm will be sufficiently transparent



Courtesy Westinghouse

High-frequency transmission tubes like these keep the Navy's land stations in touch with our fighting ships

From Triode

HOW THREE-ELEMENT TUBES

ADDING a grid to the diode gave electronics the triode, a tube of such sensitivity and usefulness that any further development might at first thought seem superfluous. Yet modern electronic devices, including the home radio, make use of four, five, and even seven-element tubes. Are these extra electrodes added merely to make tubes more complicated, or are they truly improvements on the simple but practical triode?

The answer lies in the fact that the triode is mechanically simple but extremely complicated from an electrodynamic viewpoint. It has, for example, two grave faults that limit its usefulness as an amplifier.

We have seen that the current passed by a triode varies with three things: the heater temperature that governs cathode emission, the plate voltage that attracts the emitted electrons, and the charge on the grid. But ideally only one of these should affect the tube current —the grid potential. We can maintain the heater temperature within close limits, so it offers no trouble. The grid potential necessarily varies with the incoming signal. We can also supply a fairly constant plate current. A typical amplifier circuit with these elements is shown in Fig. 1 of the drawings.

The loudspeaker (or the plate resistor, if this is an earlier stage in a resistance-coupled amplifier) must be connected in the plate circuit so that the plate current will flow through and activate it. Let us imagine that 1 milliampere is flowing through the tube and this load resistance, whatever its nature. In other words, the power-supply voltage of 250 volts is sufficient to force 1 milliampere through the total resistance of the plate circuit at this moment. Part of this resistance is the tube itself; the other part is the load.

Part of the potential of 250 volts is therefore expended in overcoming the resistance of the load; the remainder is applied to driving the current through the tube. The voltage necessary to force a given current through a resistance is called the voltage drop; it represents a loss in potential across that resistance and can be found by multiplying the current in amperes by the resistance in ohms, the product being expressed in volts.

Assuming a reasonable value of 100,000 ohms for the load in this circuit, and a current of 1 milliampere, the voltage drop across this resistance is 100 volts. Therefore the potential applied to the plate is actually this much less than the 250 volts supplied.

FIRST STEPS IN ELECTRONICS

Limited only by cost and circuit complications, a pentode, such as the one shown at left, is almost always used when the amplification required is great

Amplification in a tetrode, like the one at right, is also great, but the pentode is now largely taking its place

to Pentagrid

By
JOHN W. CAMPBELL, JR.

WORK . . . AND WHY SOME IN YOUR RADIO HAVE SEVERAL GRIDS

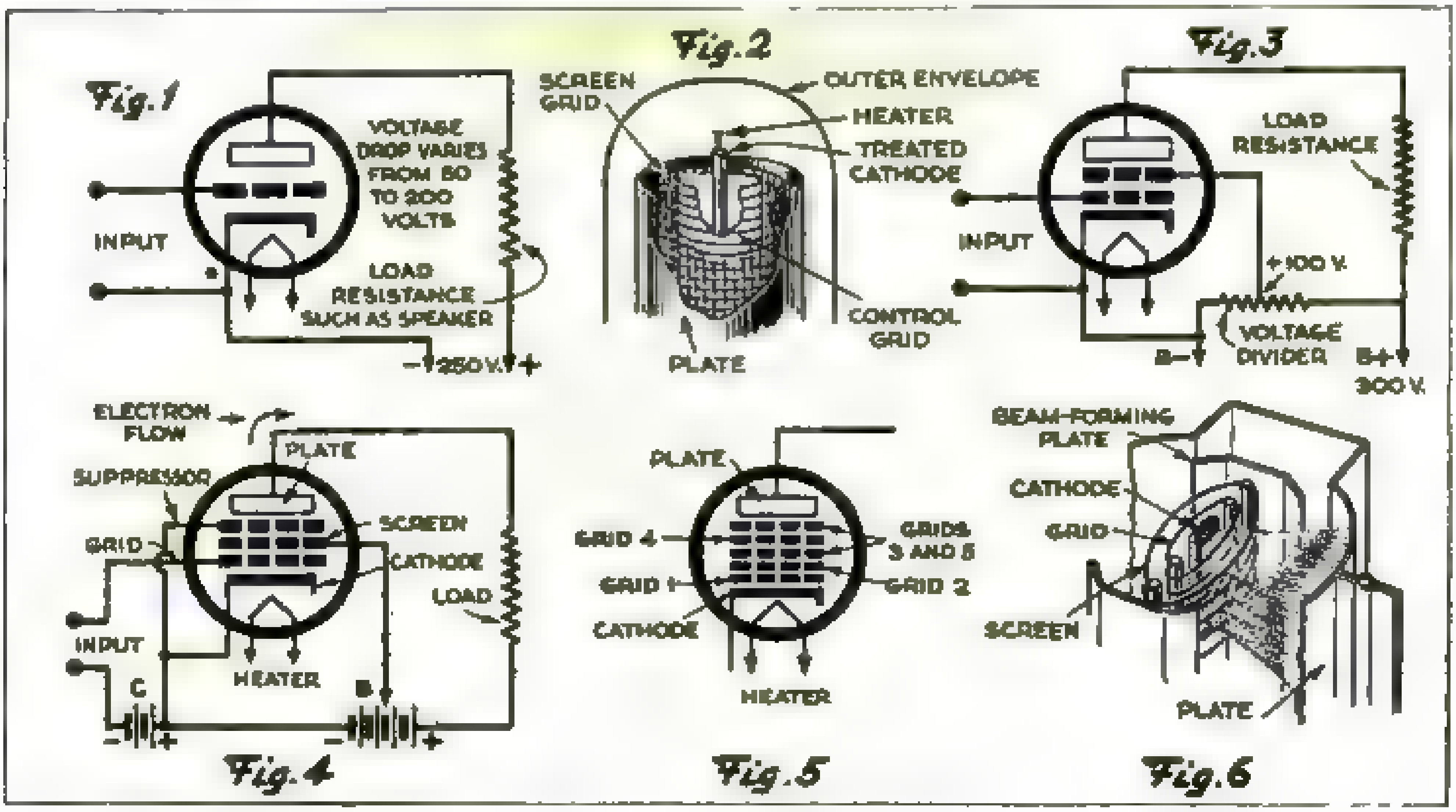
If, now, the grid of the tube becomes less negative in response to the signal, more electrons and therefore more plate current will flow. Suppose that this is now 2 milliamperes. Immediately the voltage drop across the load is 200 volts instead of 100, and only 50 volts is applied to the tube. This lower plate potential means that fewer electrons will be drawn from the cathode, and the plate current will promptly decrease. The result is that we do not obtain the amplification that would be justified by the original change in grid potential; the tube does not respond faithfully to signal variations because changes in plate voltage tend to cancel out changes in grid voltage.

This takes place, of course, at a certain critical point below which the tube performs well. Nevertheless, this inherent characteristic limits the amplification that can be obtained from a triode.

It is limited also by the second fault. Small as they are, the grid and the plate form the two plates of a tiny condenser, with a minute but quite measurable capacitance. If the grid is charged with electrons, these will repel a like number of electrons from the plate, as surely as in the case of any other condenser. Similarly, a charge on the plate induces a charge on the grid, and changes in the plate potential will induce changes in the grid charge. But a change of charge on the grid during normal operation will change the plate-current flowing across the tube and, therefore, the plate voltage.

Consider what happens if a slight accidental disturbance of the plate current lowers its voltage by .1 volt and this causes a change of only .001 volt in the grid potential. If the tube amplifies 200 times, that change in grid voltage immediately changes the plate voltage 200 times .001 volt, just as any other voltage of that magnitude applied to the grid would. But that means a change of .2 volts in the plate potential, twice as much as the original accidental change. In turn, this induces a .002-volt change in the grid charge, which causes a .4-volt change in the plate. But this again induces a .004-volt grid change, and so forth, until the tube goes into oscillation, bouncing those self-induced charges back and forth at a rate dependent on the values of resistance, inductance, and capacitance in the circuit, and becomes useless for anything else.

Of course, so long as the amplification factor of the tube is less than 100—that is, less than the capacitance, or the coupling ratio between grid and plate—it won't oscil-



late. Or, if that coupling effect is reduced so that a 1-volt plate change causes only, say, a 1/1,000-volt grid change, an amplification factor of 1,000 times is possible.

The addition of a screen grid between the control grid and the plate overcomes both these faults of the triode in a very large measure. The tetrode tube has that screen as its fourth electrode, as shown in Fig. 2.

Figure 3 shows a typical tetrode amplifier circuit. The screen separating the control grid and the plate practically eliminates the condenser effect between them; fluctuations of plate voltage have far less effect on the grid, and much greater amplification is possible without having the tube go into self-excited oscillation.

Furthermore, the screen cuts off the plate's attraction for electrons near the cathode; the plate can no longer have much effect on the electrons emitted, and hence no great effect on the strength of the electron current, which now depends on the potentials of the screen and control grids almost exclusively. But although electrons are accelerated from the cathode to the screen by the positive voltage applied to the latter, they are not stopped by the screen. Almost all flow through it and reach the plate.

Since the screen is connected directly to a source of potential, there is no voltage drop, and the charge on the screen does not vary greatly with the plate current. True, there is a condenser effect between control grid and screen grid now, instead of between grid and plate, but there is no amplification of induced potential changes, which are therefore very small. The result is that, whereas triodes are limited to an amplification gain of about 100 times, tetrodes can amplify several hundred times.

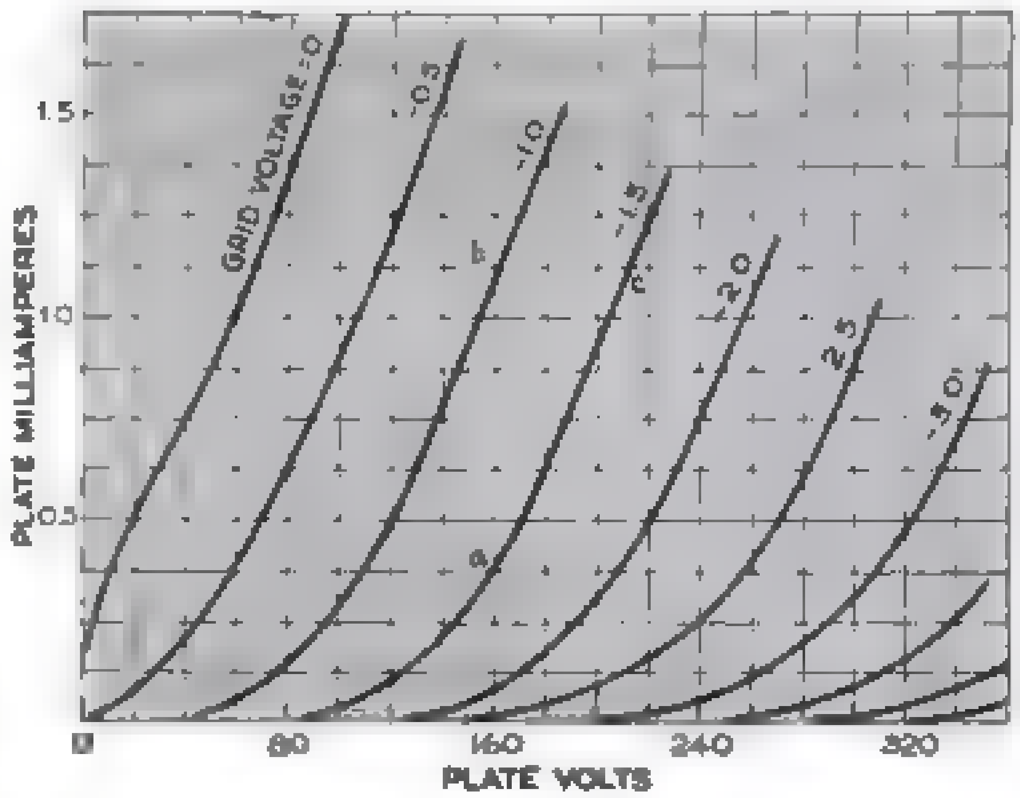
But the tetrode has one drawback. Ideally, changes in plate voltage should effect no changes whatever in the plate current; grid voltage alone should do that. What makes the tetrode fall short in this respect is secondary electron emission.

It was previously shown that one way to get electrons out of metal is to blast them out by bombardment with other electrons. If an electron, accelerated to tens of thousands of miles per second by 100 volts of potential, crashes into metal, it may knock from two to 10 secondary electrons out of the metal atoms like chips of broken rock flying up at the impact of a high-velocity bullet.

If the screen of a tetrode is at 100 volts, and the plate of the tube is also at 100 volts with respect to the cathode, electrons drawn across the tube will, for the most part, miss the fine wires of the screen and hit the plate. The impact will knock out secondary electrons with considerable violence. If the screen and plate are at the same voltage, some of these secondary electrons will be collected by the screen instead of falling back to the plate. Since that constitutes a flow of current from plate to screen, it diminishes the total plate current available outside the tube. If the screen is at 100 volts, and the plate falls to 80 volts, nearly all the secondary electrons will go to the screen, causing a marked drop in plate current. The effect is decidedly annoying except in certain special applications. Luckily it can be eliminated.

If a third or suppressor grid is placed between the screen and the plate, we have the modern pentode amplifier, shown in Fig. 4. It is so satisfactory that the tetrode has been almost entirely abandoned; the triode continues in use because of the simplicity of its circuits in low-frequency amplifiers and because of special advantageous properties at extremely high frequencies. The suppressor is simply another fine-wire structure which in some pentode tubes is connected within the tube directly to the cathode, and in others is supplied with a base pin which permits it to be so connected externally or used in some other way for special applications. Being strongly negative with respect to the

LOW-AMPLIFICATION TRIODE CURVES



To increase plate current from a to b with the plate at 160 volts, a .5-volt change in grid voltage is needed, while to obtain the same plate current at the original —1.5-volt grid potential, as at c, plate voltage must be increased to 210 volts. Since a .5-volt grid change increases plate current the same as a 50-volt change in plate potential, the tube amplification factor is 100

plate, the suppressor promptly drives any secondary electrons back to the plate. One of the graphs shown here indicates how nearly independent of plate voltage the plate current is. Compare this with the triode and tetrode curves.

Pentagrid mixers and converters are actually tetrodes with a triode element inserted in the electron stream. In Fig. 5, a schematic arrangement of a pentagrid type is shown. Grids 1 and 2 constitute the grid and plate of a triode, which can be connected in a regular triode oscillator circuit. This will impress on the electron stream flowing through the tube an oscillation, but grid 4 can be used to control this electron stream further. Grids 3 and 5 act as shielding grids to prevent the voltage applied to grids 1 and 2, or the plate-voltage variations, from affecting grid 4. This tube can be used to mix two different frequencies, or it can serve as a combined oscillator mixer. If radio-frequency oscillation is applied to grid 1 and an audio-frequency voltage is applied to grid 4, an audio-frequency-modulated, radio-frequency plate current results.

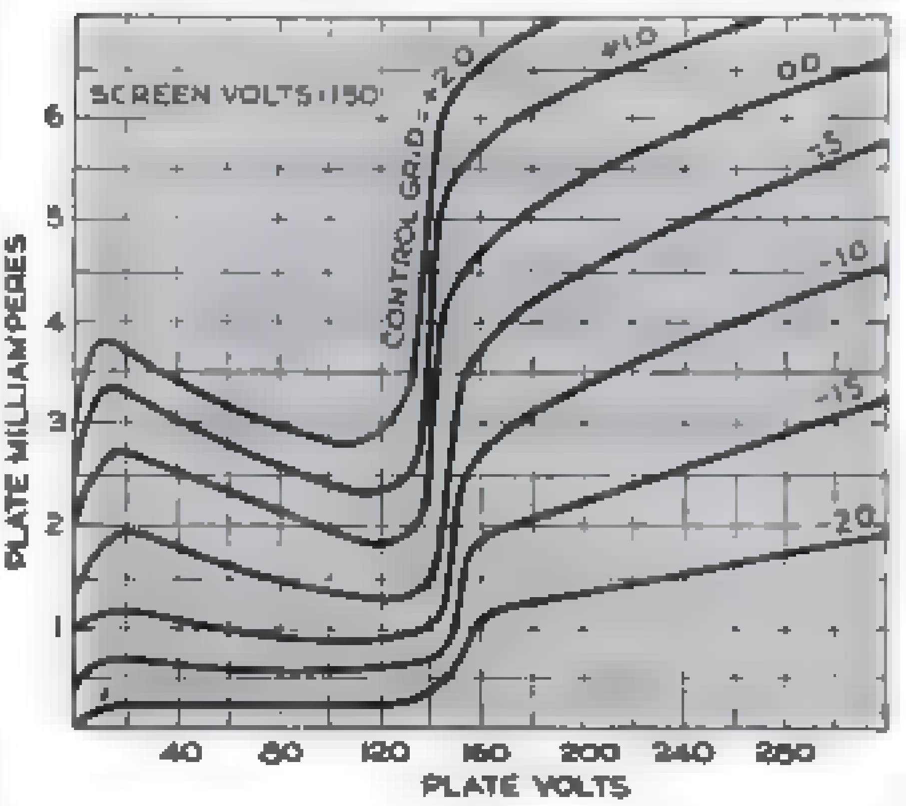
One more important tube type is the beam-power tube, a type of power-output tetrode that, because of mechanical design and shaping of the electrodes, is a "virtual pentode" in which the suppressor grid is replaced by space-charge effects.

Figure 6 shows the typical beam-power tube structure. The wires of the control grid and the wires of the screen grid are carefully arranged in such a fashion that the spaces between them, through which the electron streams must flow, are aligned. Each screen-grid wire is directly behind a control-grid wire. The result is that the electrons flow across the tube in sheets or beams like sunlight falling through a barred window. Since most beam-power tubes are designed to handle comparatively heavy currents, these beams consist of trillions of electrons; the space-charge effect they produce is quite intense and is equivalent to that of a regular grid charged to a strong negative potential. The result is that secondary electrons emitted by the plate are hurled back.

A typical beam-power tube, the 6L6-G, can handle as much as 300 milliamperes at 100 volts; two used in push-pull are frequently used for small radio transmitters, for high-power audio-frequency amplifiers, or in small induction-heating devices, since they can develop about 50 watts of power at any frequency from 10 to 10,000,000 cycles.

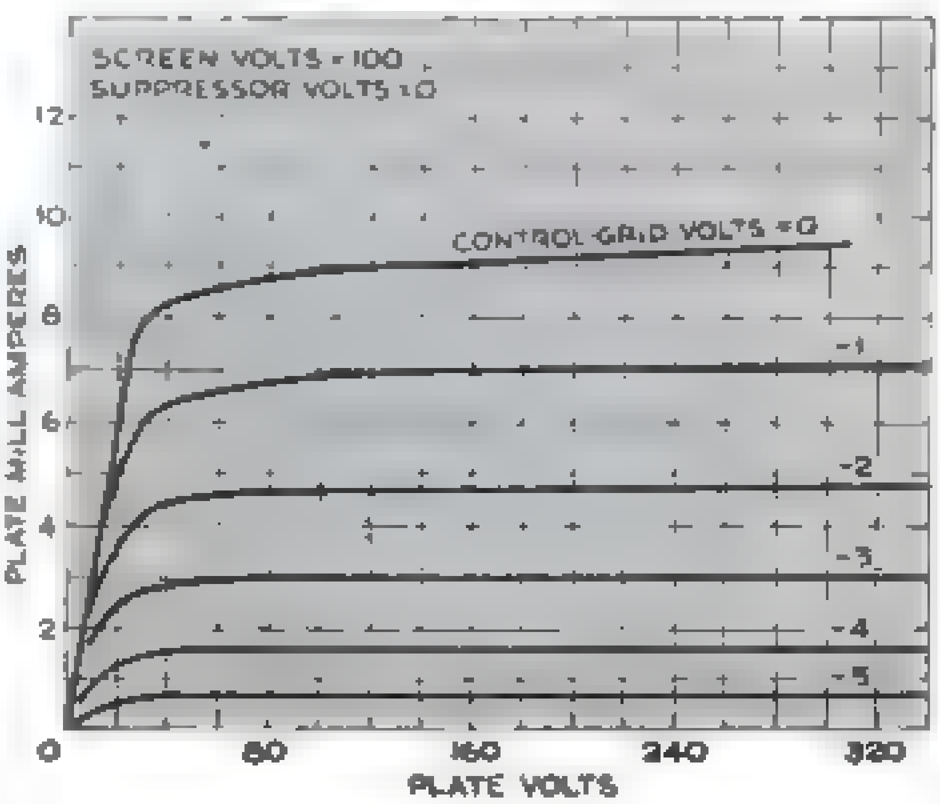
Many single tubes contain nine, 10, or even more electrodes, but generally they are simply combinations of two or more tubes in one envelope. Thus a 6SQ7, listed as a "duplex-diode hi-mu triode" is simply an ordinary triode amplifier in the same envelope with two small diode rectifiers, all using the same cathode.

PERFORMANCE OF THE TETRODE



So long as plate voltage is higher than screen-grid voltage, a tetrode has a high amplification factor, but, with a heavy plate current, voltage drop may reduce the plate potential to that of the screen grid, at which point the output is distorted, as shown by sharp slopes on the graph. This is due to secondary electrons the screen draws from the plate

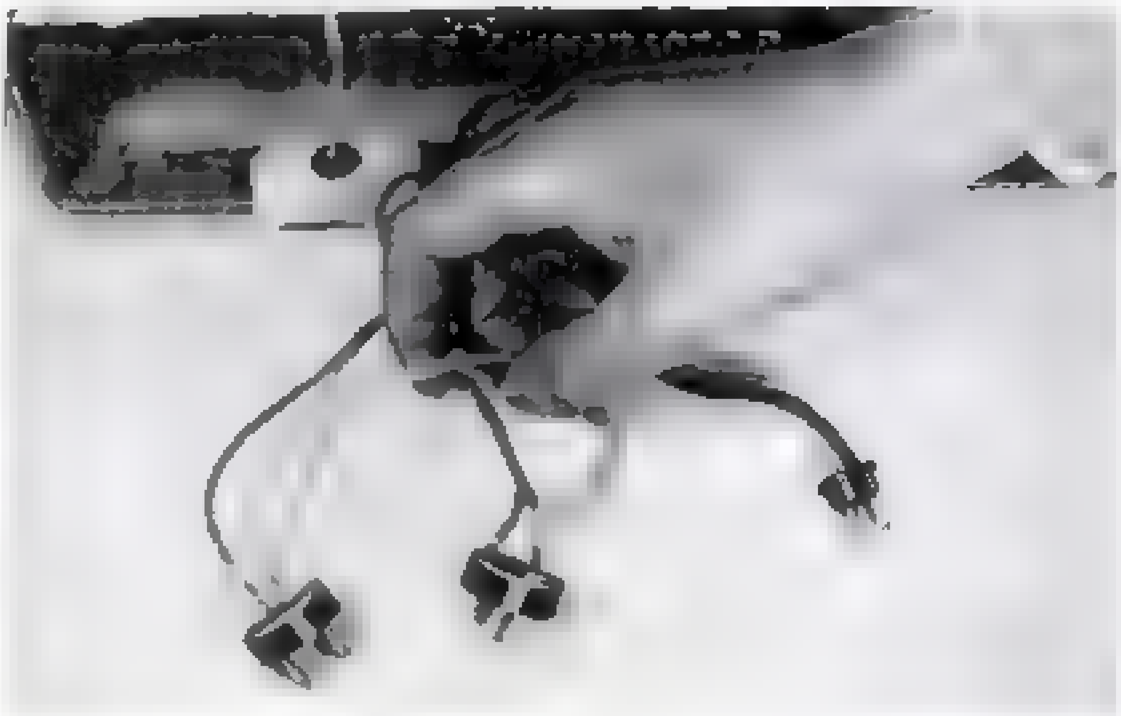
PENTODE CHARACTERISTICS



Pentode curves are smooth and almost flat and parallel. A 100-volt change in plate potential produces only about the same increase in plate current as a .1-volt grid change would cause. The amplification is therefore on the order of 1,000, as indicated by the almost imperceptible slope on this graph of a 6SJ7 voltage amplifier

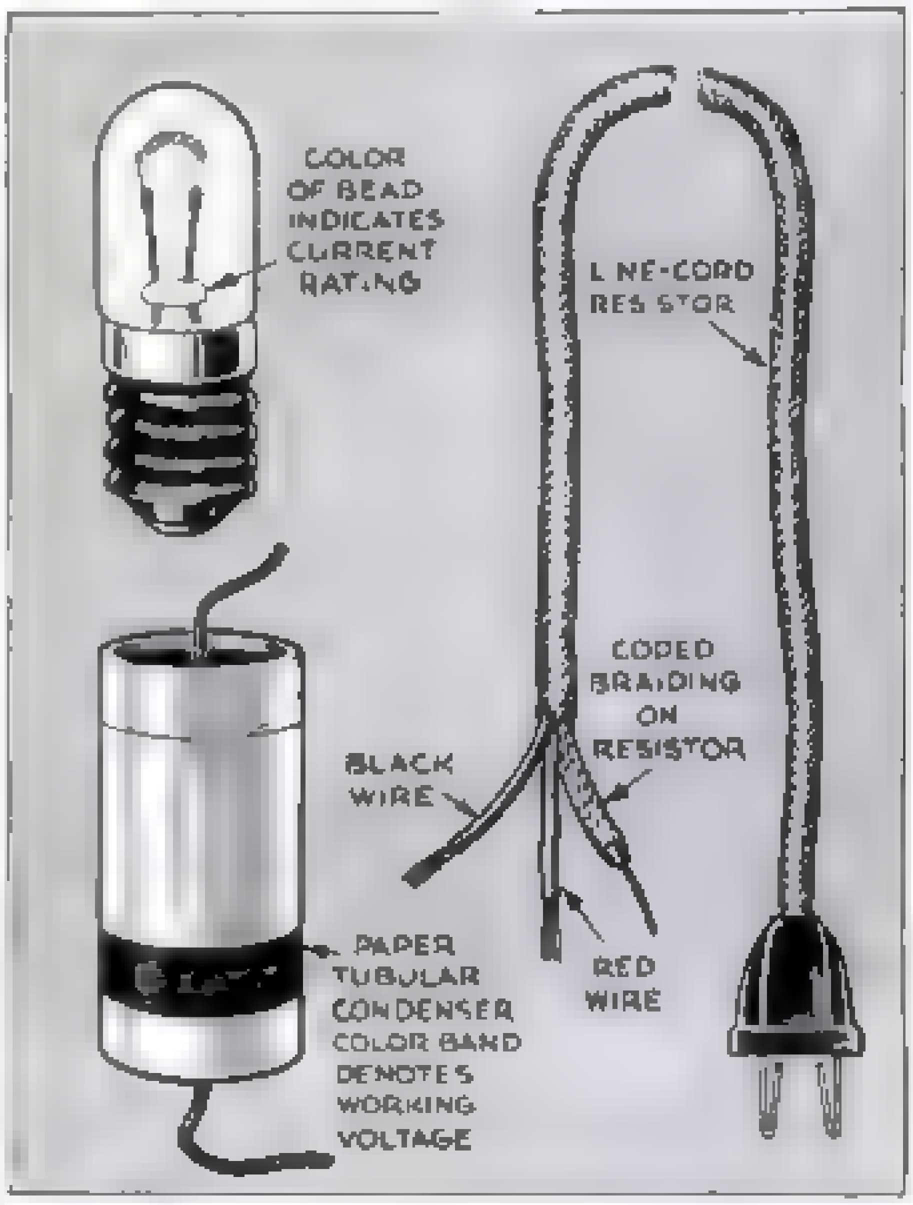
Servicing Your Radio

COLOR coding is being employed increasingly by manufacturers of a variety of radio parts as a help to both the professional and the home serviceman in distinguishing the various values of equipment. Dial lamps, battery cables, line cords, and condensers are some of the accessories that are being so identified.


Color reveals the right connections for these battery cables

Several types of dial lamps are manufactured to meet the filament-voltage requirements of different sets. In color-coded bulbs, the beads on which the filament is mounted now come in four hues—brown, blue, pink, and white. A dial lamp with a brown bead is rated at 6.3 volts and 0.15 amp., and is employed in sets having tubes of similar rating, such as the 12SQ7-GT/G diode triode. A blue bead indicates that the filament voltage of the dial lamp is 6.3 volts and 0.25 amp. for use in sets having 6.3-volt, 0.3-amp. tubes. White is used for lamps of 2.5 volts and 0.5 amp., while a pink bead identifies lamps of 2 volts and 0.6 amp. for battery sets.

Many battery and three-way portable sets have a color-coded battery cable that will tell the serviceman immediately what wire should be connected to which battery in case instructions are lost or a battery plug is broken. The red wire is usually A+; the black wire, A−; the blue wire, B+ maximum; the yellow one, B−; the white, B+ intermediate (22½ or 45 volts); the brown, C+; and the green, C—. They leave no need for guesswork.



The voltage of the dial lamp is shown by the color of its bead, and color also tells the value of the resistor wire in the cord. Bands mark condensers

There is a special color code employed for identifying the resistance value in line cords used in A.C.-D.C. receivers. As a rule, these line-cord resistors have three wires, one red and one black, and a third wire that is the color-coded resistor wire. In this code yellow means 135 ohms; blue, 160 ohms; white, 180 ohms; green, 200 ohms; light brown, 220 ohms; orange, 260 ohms; grey, 290 ohms; maroon, 315 ohms; and dark brown, 360 ohms. However, if the value is stamped on the plug, the color code does not apply.

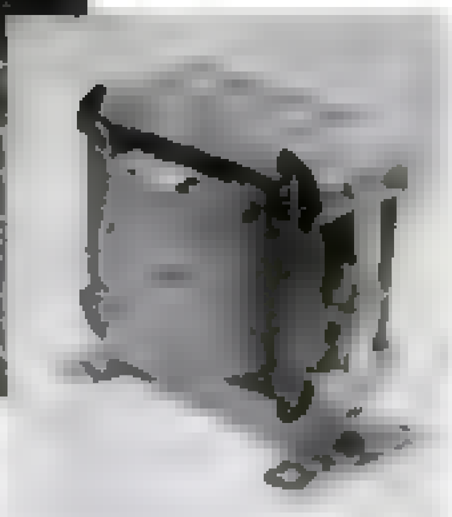
Some manufacturers use voltage-coded paper tubular condensers in their sets. A colored band denoting working voltage is placed around one end of such condensers. For example, a brown band denotes a D.C.-voltage rating of 100 volts. Other ratings are represented as follows: red, 200 volts; orange, 300 volts; yellow, 400 volts; green, 500 volts; and blue, 600 volts. No matter which way a condenser may be turned in a receiver, this method of coding with a colored band provides instant identification of its D.C.-voltage rating.

A color code is also used by several manufacturers of phonograph motors to designate the A.C. cycle for which they were designed. If, for instance, a motor is built for use on 25 cycles, the manufacturer usually places a white spot somewhere on the frame. The frame of a motor built for 50 cycles is marked with a green spot. No marking is used on 60-cycle phonograph motors.

radio ideas

A RECORD-MARKING DEVICE designed in the shape of an ordinary phonograph record is provided with a scale that makes it possible to "pick up" or start playing transcriptions at any preselected spots The graduated disk, made of cardboard, eliminates the defacing of records and enables sound effects to be timed with considerably more precision than was previously possible

TRANSFORMER CORES made of a rolled silicon-alloy steel are reported to have permeability values approaching those of the best nickel alloys. The new alloy, developed by Westinghouse Electric & Manufacturing Co., is in the form of strip and is wound on a rectangular mandrel (left). The cores are then annealed at high temperatures and impregnated with a plastic compound that produces a solid unit smaller and lighter than cores of other laminated construction. After the cores are cut in two parts to permit the insertion of coils, they are reunited in a manner that preserves their characteristic of low core losses.



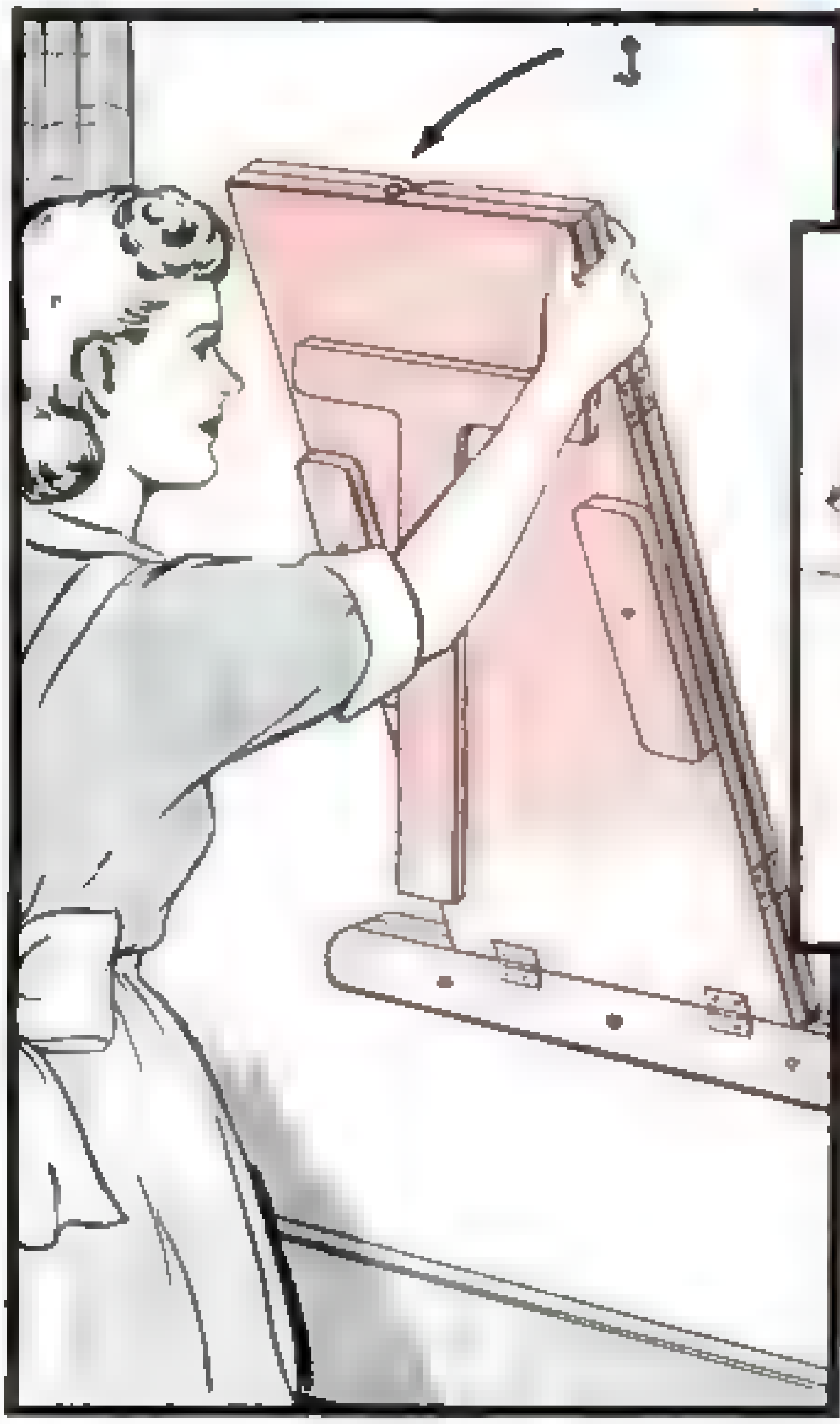
NEW STATIC NEUTRALIZERS employ a set of electronic tubes in such a way that they are automatically adjusted to discriminate between static and the desired signal and to intercept the former no matter how powerful it may be. In one test, a 25,000-volt spark from an ignition system was projected directly upon the antenna of the receiving set. The neutralizer eliminated this so effectively that it was possible to tune in a short-wave program from Europe It can be built into any radio set, according to its makers, the Goodyear Tire & Rubber Co., whose entire output of the device has so far been absorbed by the armed forces, for whom it was primarily designed.

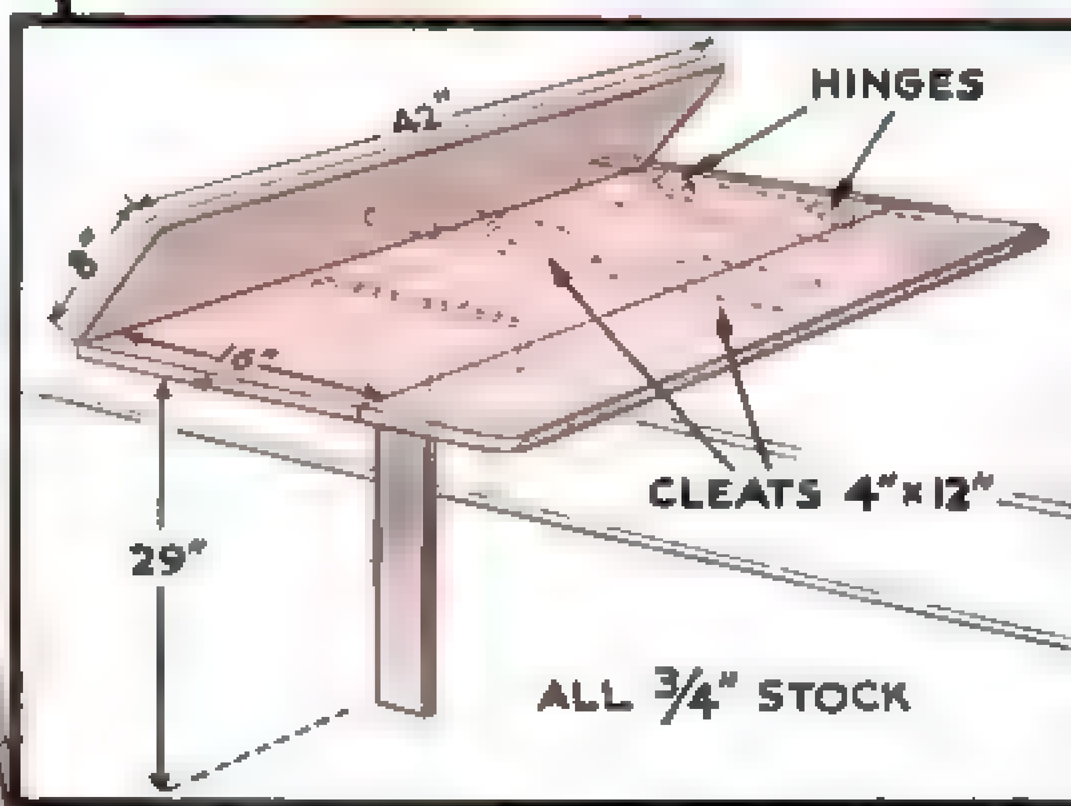
No crumbs will scatter when you are grinding dried bread, if you catch them in a paper bag held around the grinder outlet with a tightly tied cord or rubber band

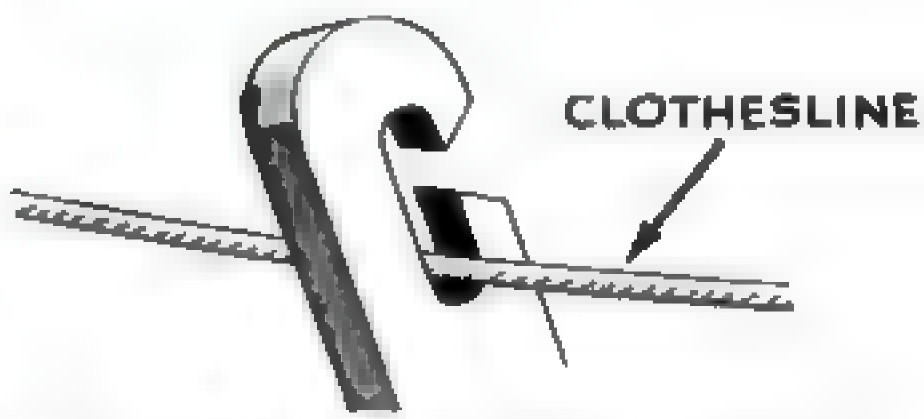
When you want to drive a nail in a plastered wall, cover the spot with cellulose tape and drive the nail through it. The plaster won't chip under the tape

Clogged sink drains can often be cleared without benefit of plumber if a small rubber ball cut in half is manipulated for suction on top of the strainer.

KEEPING

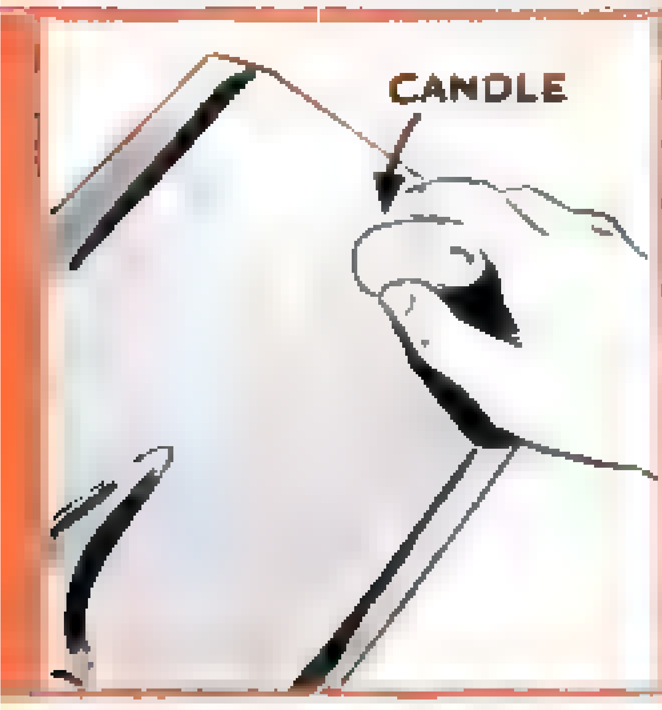




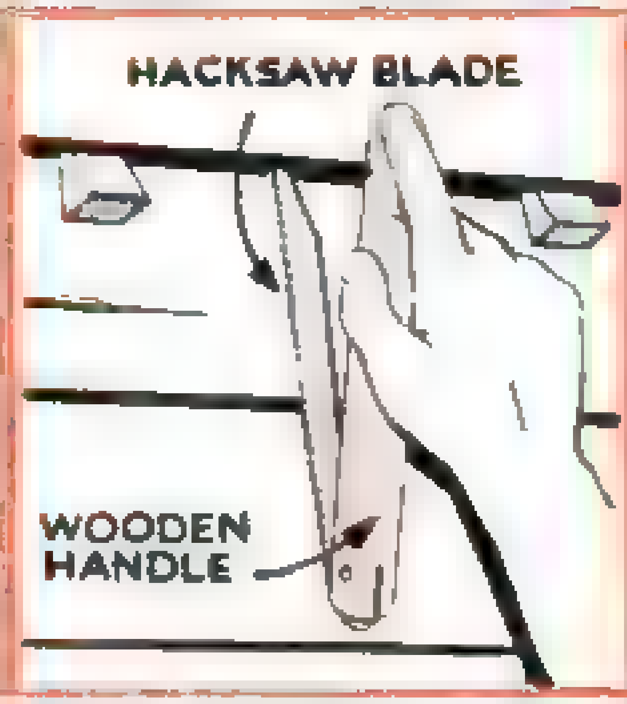


If your kitchen lacks space for a dining alcove, a folding table that can be raised up out of the way against a wall when not needed may solve your problem. It consists of a 16" wide center made of one piece or built up, folding side extensions, a leg, two cleats, and a wall brace for the hinges

Sagging clotheslines won't slide off props and let their burden become soiled if slotted props, such as the one shown above, are used. Bore two holes first to form the ends of the slot; then, with a coping saw, cut the V-shaped notch in from the edge and saw out the stock between the holes



Snow sticking to shovels costs sidewalk cleaners much time in knocking it off. Put a coating of ordinary candle wax on the scoop, and the snow won't stick



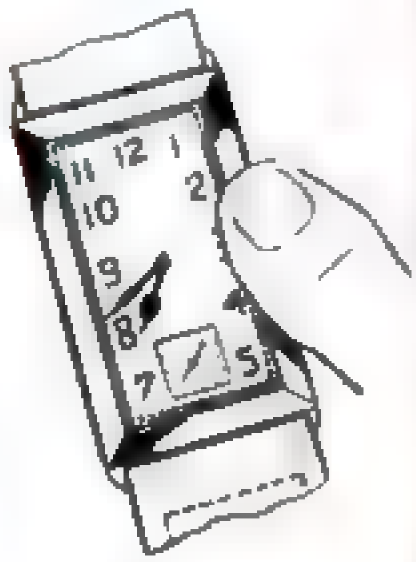
A broken hacksaw blade, fixed to a piece of broomstick, cuts away a damaged shingle quickly when its pointed tip is thrust beneath an overlapping shingle

The edge of an overall pocket can be saved from much wear and tear if it is reinforced by a coating of fingernail polish. The polish will provide a hard, smooth edge

THE HOME SHIPSHAPE

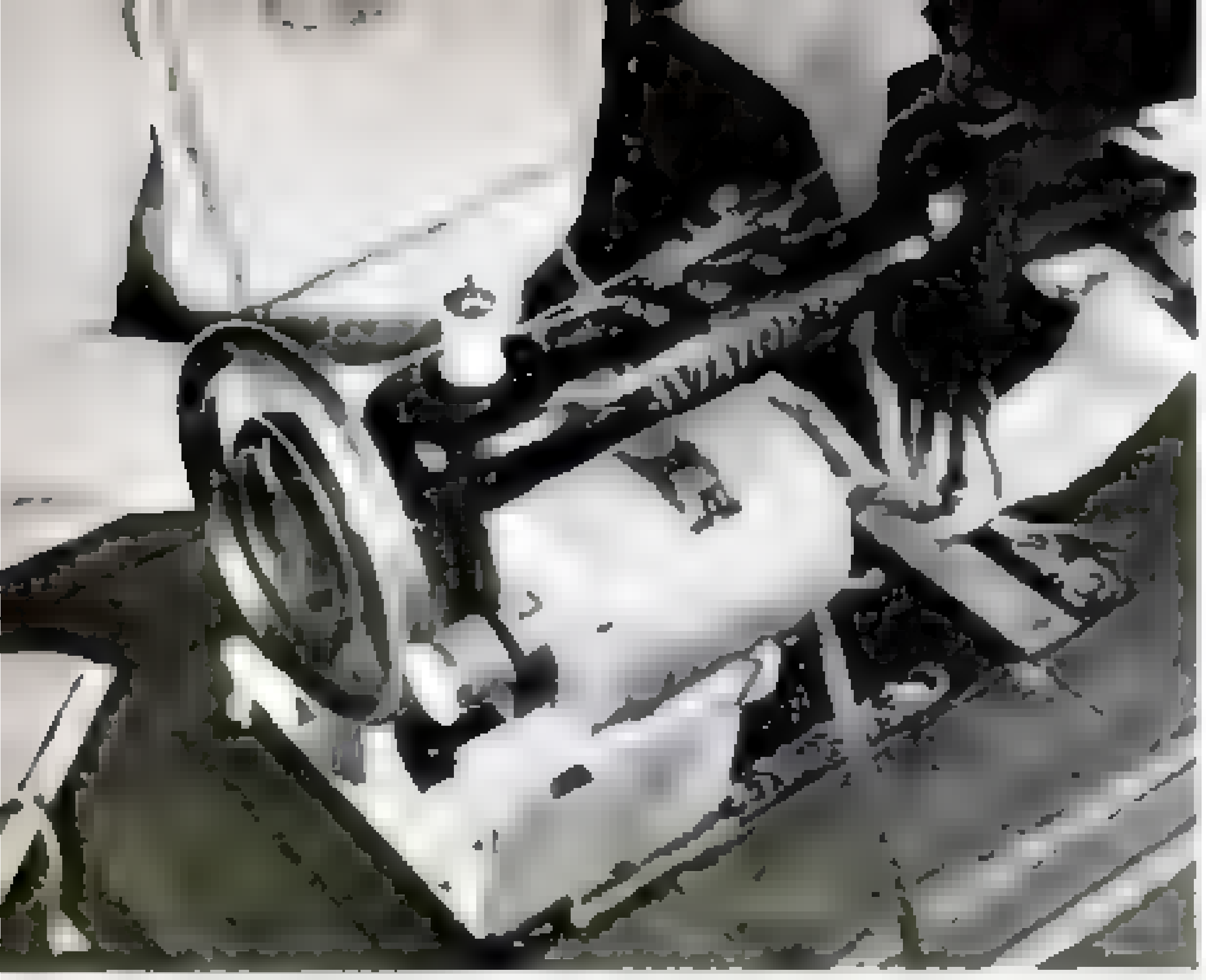
Even after an oil-can spout has been damaged beyond repair, the base will be worth saving to use as a paint container when a small job is to be done. A can of this type won't upset easily

When the crystal of a watch does not fit tightly, small crevices around the edge of the case may admit moisture and dust. Ordinary beeswax, first warmed in your hand, will effectively seal such cracks if tiny amounts are forced in with the fingers



The nail picker at the left will prove a big help on a job where a large number of nails must be used, saving your fingers when you dip the nails out of a keg. Cut the body from soft wood. Drive nails, equally spaced, through the broad end and bend them slightly to assist the clutching action. Handle the picker like a scoop

Many a costly paint job has been disfigured by replastered cracks in a wall breaking out anew. To avert such an occurrence, a can opener of the punch type should be used to gouge the cracks to a depth that will remove all loose particles and provide a deep, beveled groove to hold new plaster



FOR SPEEDIER

ELECTRIC

ELIMINATES TREADLING

By WALTER E. BURTON

MOTORIZING an old-fashioned foot-drive sewing machine is a simple operation that will end much of the drudgery of sewing. It consists chiefly of securing a suitable motor, building a motor mount, and attaching it to the machine head or cabinet.

Any small constant-speed induction motor of sufficient power may be used. If you must use a brush-type universal motor in this way without rheostat control, a governor of some kind will be necessary to limit top speed when the motor runs unloaded. A constant-speed motor has at least two advantages over the rheostat-controlled universal motor usually provided for a sewing machine. For one thing, sewing speed can be reduced without loss of power simply by lessening the pressure of the driving pulley against the sewing-machine flywheel. Another advantage is that, since this type of motor is free of sparking, it will not interfere with radio reception.

The motor used here was rated at 1/40 hp. and had a constant speed of 1,725 r p m It was equipped with a pulley made from a 1" length of 1" maple dowel. A small metal pulley that could be faced with rubber or leather, or a regular sewing-machine motor pulley having a rubber face, would serve as well.

First, a hole was bored in the dowel for the motor shaft, and at right angles to it a hole was drilled and tapped to receive a ¼"-20 setscrew. With the pulley on the shaft and the motor clamped in a vise, the pulley was trued up with a turning chisel as if on a lathe, and the face was contoured to match the sewing-machine flywheel. A strip of soft leather, with a hole punched for the setscrew, was cemented to the pulley and bound with thread while the cement dried. Inner-tube patching rubber can also be used.

Mount the motor on a swinging bracket so that, when the bracket is tilted forward, the pulley will drive the flywheel. The shape and size of the mount will depend on the motor. To allow the head of the machine to be dropped, the motor was in this case attached with a butt hinge having a removable pin. The motor can be detached quickly by pulling out the pin and disconnecting the cord to the control pedal. With another machine or motor, it might be better to attach the mount to the cabinet.

Install either a coil spring, a strip of clock spring, or a suitably bent piece of piano wire so that its tension normally holds the motor pulley away from the flywheel.

Although the motor itself may be run

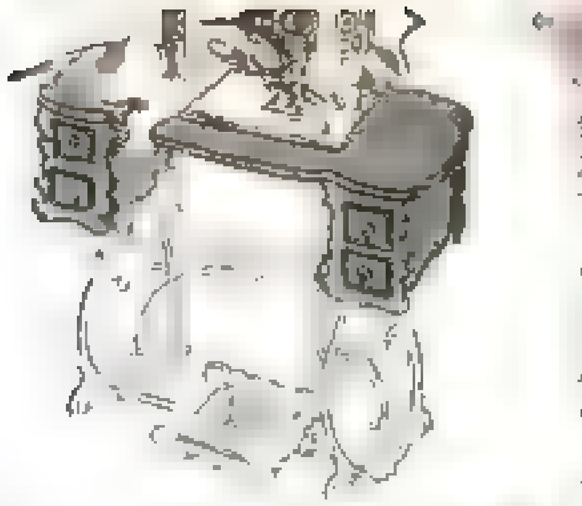
With the motor connected, a lathe chisel and board rest are used to shape and true the driving pulley

A piano-wire spring is installed to hold the motor away from the flywheel unless the pedal is pressed

SEWING ON THE FIRESIDE FRONT . . .

MOTOR DRIVE

OF OLD-FASHIONED MACHINE

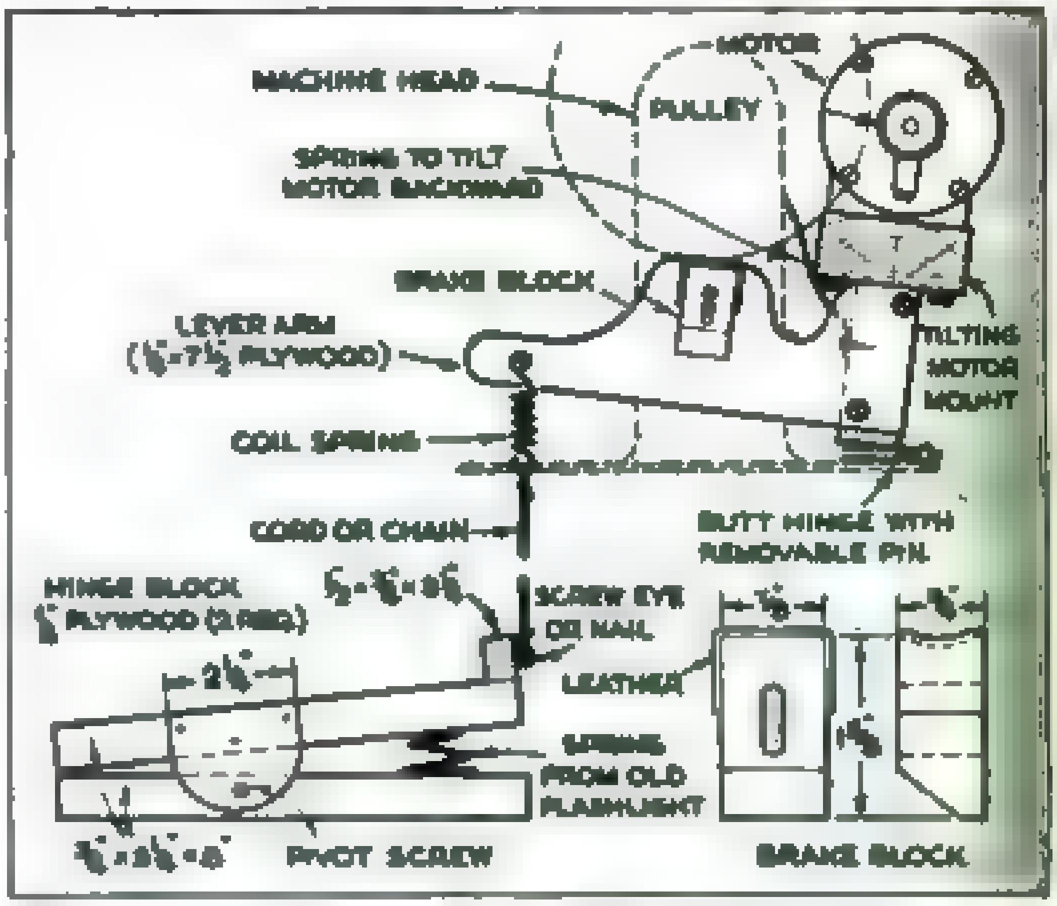


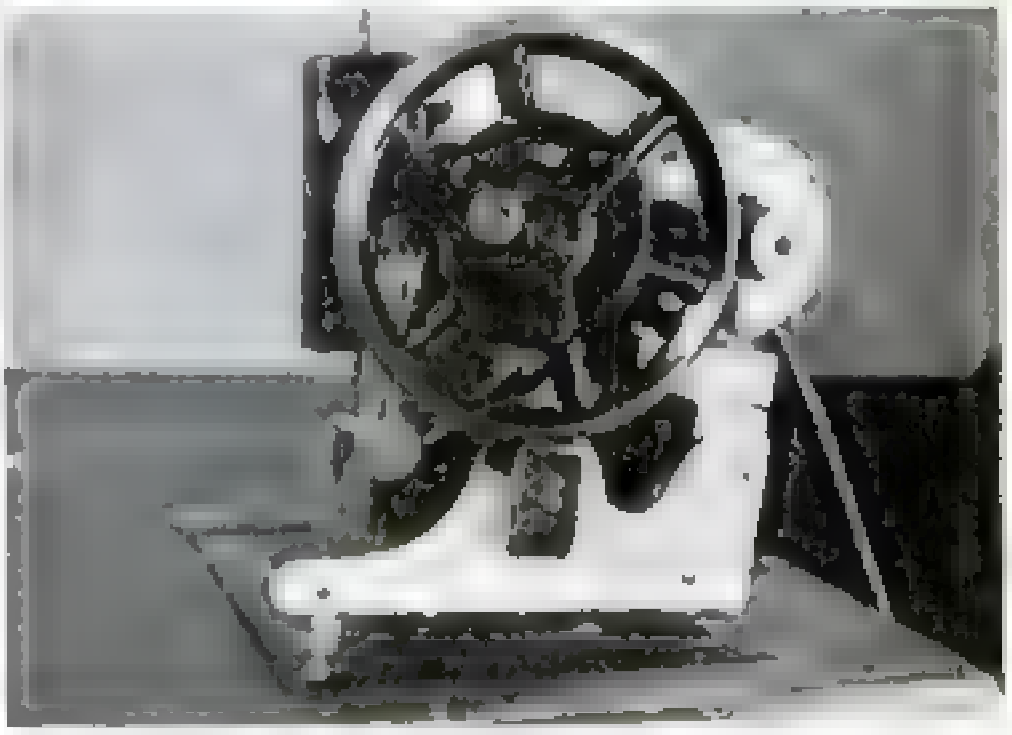
continuously during the period the machine is being used, it should be equipped with a switch for convenience. Some provision should also be made for using the bobbin winder. In this case, a strong rubber band was run around the winder pulley and the unused belt pulley inside the flywheel.

From ¾" plywood or similar material, cut an arm to extend from the motor mount to a point slightly beyond the forward belt hole in the base of the machine head. Directly below the center of the flywheel there should be a hump on which a brake shoe can be mounted. A short coil spring is fastened near the end of the arm, and a cord or chain is dropped through the hole to a foot pedal.

This foot-control unit is made of two pieces of ¾" stock hinged together, as shown, so that pressure will pull the extension arm down and the motor mount forward to regulate contact between the motor pulley and the machine flywheel. The coil spring limits the force that can be applied. Some machines may have treadles so balanced that the cord can be attached to them, obviating a separate foot-control unit.

Releasing pressure on the foot control allows the motor-mount spring to press the motor back, which interrupts the friction drive between the pulley and flywheel and also brings the brake block to bear, stopping the machine quickly. The brake block also limits the distance the pulley can draw away from the flywheel. It consists of a piece of maple, slotted to be adjustable and held to the motor-mount arm by two round-head wood screws.

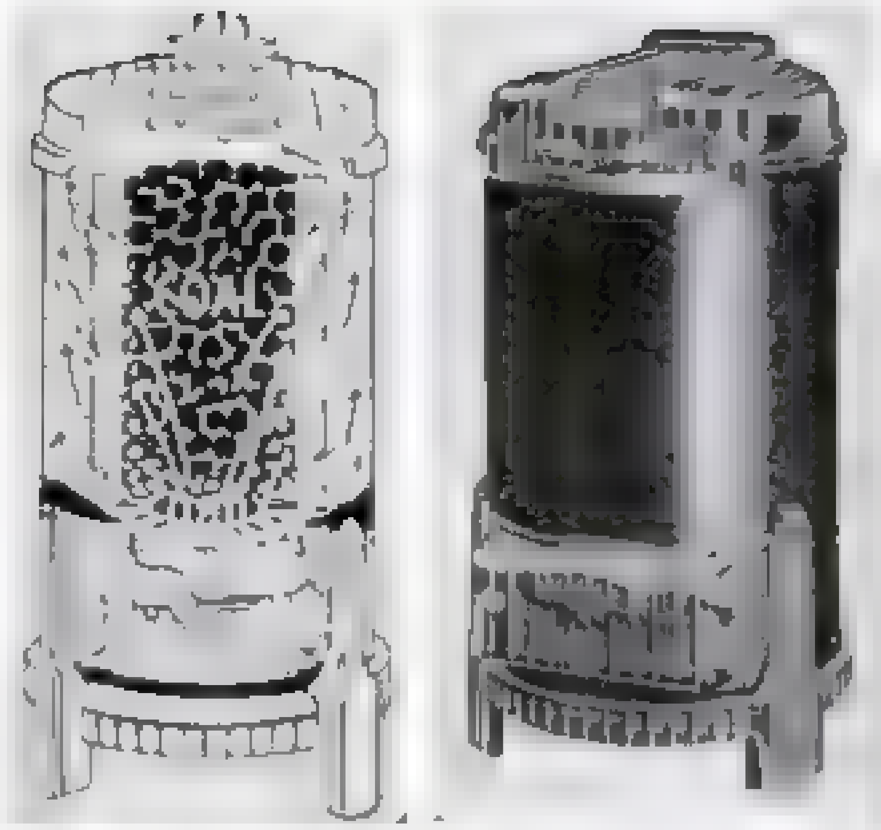




For bobbin winding, a rubber or coiled-spring belt runs between the winder and the original pulley on the flywheel, the clutch of which is disengaged. A foot-control unit, below, governs driving friction

One leaf of a butt hinge is bolted to the machine, while the other leaf is screwed to the motor mount

OF INTEREST TO HOME OWNERS



A COAL HEATER, with a capacity of 100 pounds of fuel, incorporates a new principle of construction that transforms ordinary coal into coke before the fuel reaches the place of combustion. Either bituminous or anthracite coal can be used with equal efficiency and without danger of noxious gases. In mild weather the stove will hold fuel for two or three days without refueling, and it requires attention only once a day in cold spells in the midst of winter.

An inner chamber, or fuel crib, is filled with coal which eventually is fed semiautomatically to the grate. Once the heater has been started, flames and heat from the firebox circulate around the firebrick walls of the inner chamber, gradually coking either soft or hard coal as it slowly approaches the grate. Low-grade fuels can be burned with a minimum of smoke, and with a residue only of fine ash. No clinkers are produced by the method, since the coal is thoroughly coked by the time it is ready to be burned.

PLIABLE PLASTIC TAPE requires no tacking when applied as shown above to seal doors and windows against the weather. It is sufficiently pliable to be pressed into place by hand, and its pliancy keeps it from checking or cracking. Cracks around drainboards and sinks can also be plugged effectively with this tape.

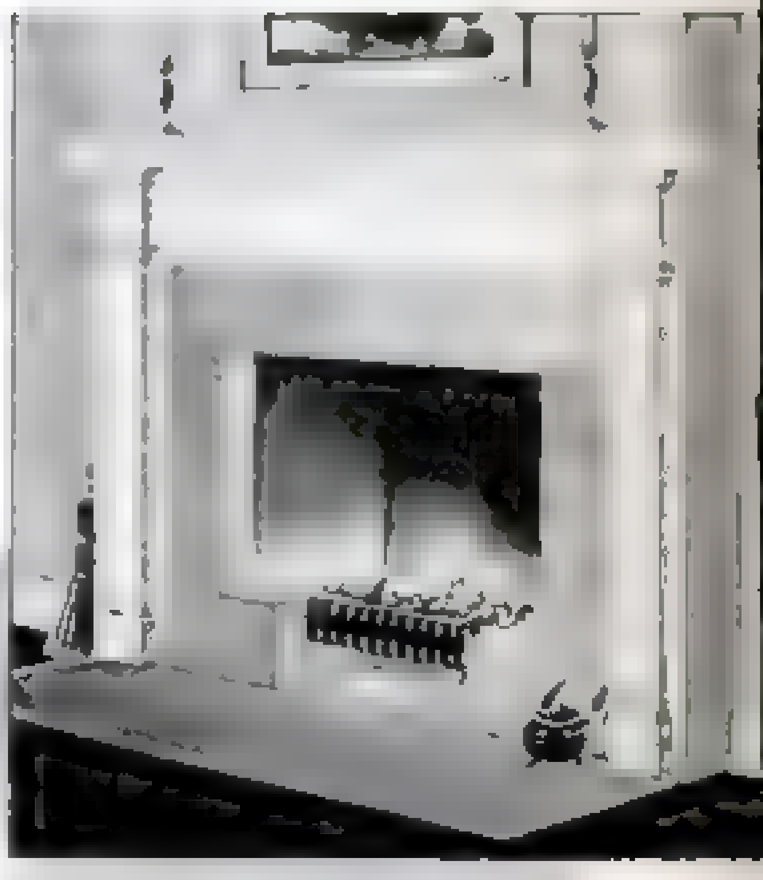
GLASS DIALS on thermometers provide easy, accurate reading of the outdoor temperature when mounted, facing inward, on the outside of a window pane. The instruments come in two parts. A base is cemented to the pane, and the dial is screwed into the base after the cement has been given time to set. The pointer is actuated by an expanding and contracting coil.

THESE WINDOW SPRINGS will eliminate rattles and drafts when inserted between the sash and the casing at each corner of a window. They have toothed edges that bite into the wood of the sash, while their curved sides slide up and down with the window, pressing it against the parting strip. They are installed with the aid of a piece of tin.

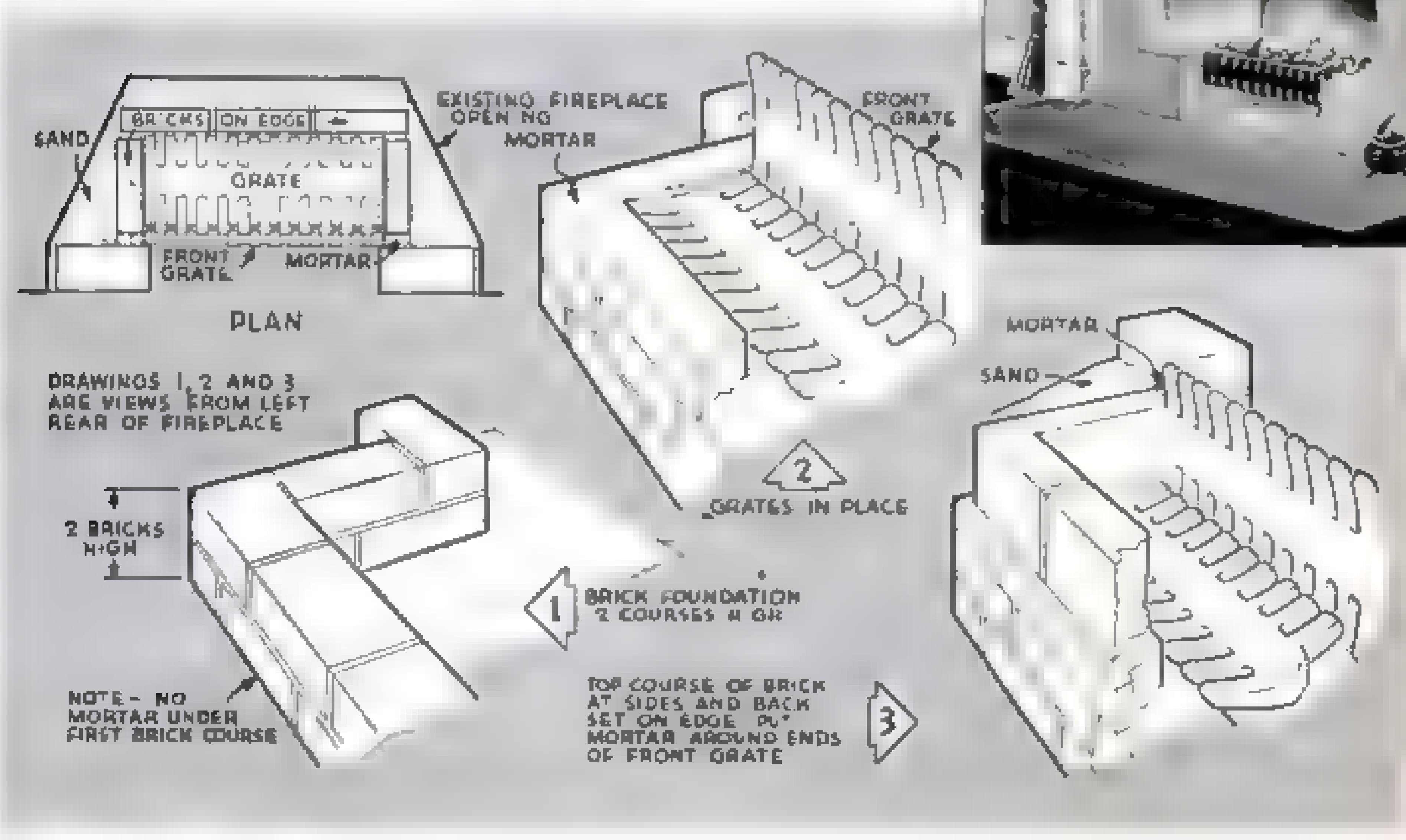
How . . . . and why TO BURN COAL IN YOUR FIREPLACE

REQUIRING only scant attention, a coal fire will keep burning in your fireplace day in and day out; and by boosting room temperature substantially, it will reduce the work your heating plant must do. Moreover, unless firewood costs you little, anthracite in your fireplace will often prove an economy in itself.

Iron grates, though scarce now, are still occasionally obtainable, and new types made of fire-resistant glass or ceramics are also on the market. You can also build a satisfactory grate from a pair of old range grates, used as indicated below. To get the most from any coal fire, the sides of the aperture must be bricked up to channel the draft through the grate, rather than beside it. Firebrick, desirable in permanent installations, isn't necessary in converting just for the duration. Similarly, the bottom course of brickwork may be left uncemented to facilitate later removal.



When lighting, build a wood or charcoal fire over the entire grate area, and add a layer of coal when it is burning briskly. Don't build the kindling fire in just a portion of the grate; the coal fire will not readily spread sideways. Once or twice a day, ashes may be cleaned out by running a poker up between the grate bars. A handy device to liven up a banked coal fire is a screen of sheet metal which intensifies the draft by blocking off the entire fireplace opening except for a 3" slot along the bottom.



FOR SAFETY ALOFT... *use the right* LADDER

By HAROLD R. TERPENY

IF A MAN misuses a hand tool, an inferior finished product is generally the worst result. But if he misuses a ladder, a fractured leg or arm is by no means an unlikely outcome. Choosing and using the right ladder for the job to be done isn't a complicated matter, but it *is* something that is of prime importance to the handy man as well as to the house painter or rigger, because even though a shaky or badly placed ladder will not always bring on an accident, it does produce a sense of insecurity which often means a hasty, carelessly performed job.

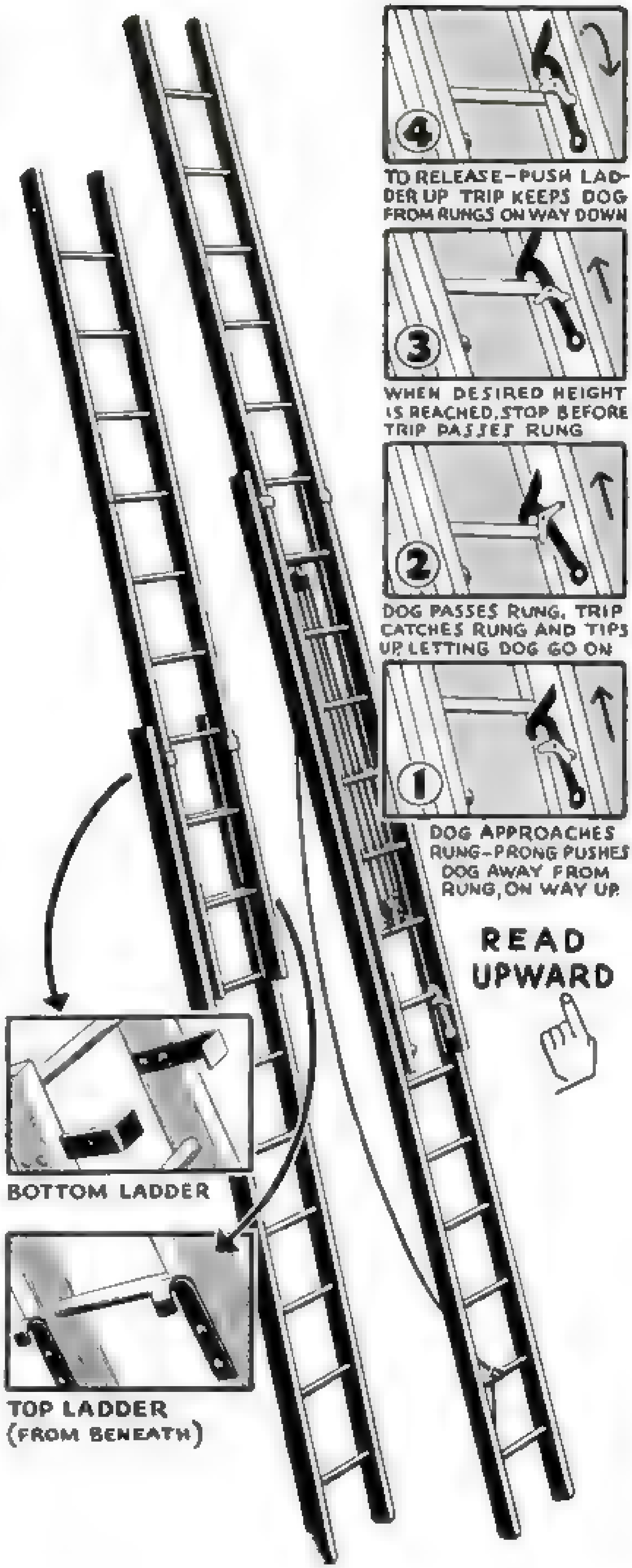
Probably the commonest member of the ladder family is the stepladder. When you purchase a new one, look particularly at the way the steps are attached to the sides. If they are braced securely or have cross rods running beneath each step, the ladder will have a longer useful life. Be sure, too, that the top and the folding shelf are big enough to hold a bucket or a few tools with some security, and that the hinged cross braces are solidly anchored.

The jump ladder, a light, two-part ladder about 10' long when unextended, is one of the handiest types. It affords much more elevation than the stepladder but can also be handled more easily than heavier extension ladders. The two parts are locked together by a pair of metal hooks, with no rope-and-pulley arrangement, and the ladder can be quickly taken apart when a single section is required. An overlap of two rungs is desirable at all times, which means that a 10' jump ladder will open safely to about 17'.

The special province of the jump ladder

House painters find use for all three types of ladders. Note the handiness of the jump ladder when separated and hooked over the roof ridgepole

Drawings at the right show details of both an extension and a jump ladder. Hooks on the jump ladder fit it for scaling. How the dogs on the other ladder work is illustrated in steps



are those heights which do not require a heavier rope-controlled extension ladder. In house painting, for example, it is particularly useful for reaching points at the second story and lower. When taken apart, it is also well suited to work on roofs, for the metal guides can be caught on the ridgepole.

Oldtime painters like to say that the name jump ladder had its origin in the impatience of a foreman who sent an apprentice some distance for a light ladder of the type. The apprentice returned with a heavy extension ladder replete with rope and pulleys. "Not that one," exclaimed the boss. "Take it back and bring the smaller one, the one without any tackle, and bring it on the jump!" When the boy came back a second time he had the right ladder. "Here's the one you asked for," he said to the foreman, "and it's strictly on the jump."

Larger two-part ladders are usually fitted with a rope and a latching device similar to that illustrated at the right. With this type the individual sections can also be used separately when the occasion arises. Do not, however, take apart a ladder of this sort without first studying the way it is roped and the relationship of the two parts—or you may find that it isn't as simple to reassemble as it looked.

Raising a fairly heavy extension ladder from a horizontal position may take a bit of practice. If no assistance is at hand, the best method is to place the base of the unextended ladder against the foundation of the house and to "walk it up." Once upright, it can be extended to the required height. *(Continued)*

If the ladder is extremely heavy, you may find it easier in the long run to separate the sections, raise each one individually, and then reassemble them. An extension ladder capable of reaching 40′ or more is usually too awkward for one man to handle.

Carpenters, roofers, and masons often use a heavy-duty ladder made with 2 by 4's for rails, into which are set 1¼" by 3" rungs. This gives an extremely sturdy ladder especially suited for use with heavy loads. Since a ladder of this type is not designed to be manhandled frequently, it's good practice to spike or rope the top to prevent slippage. Excessive springiness in the longer lengths can be controlled by running a pair of 2" by 4" braces from the middle of the ladder to the ground.

At the other extreme of ladder construction is a light, simple type which can be quickly built from 1" by 2" furring or roofing laths. Make each side rail by nailing two pieces together at one end only, and then nail the rungs to the *outer* of the side pieces, setting the rungs 12" apart, which is the standard distance in ladder construction. When all the rungs are on, spring the inner halves of the rails in a slight bow by pushing on the unnailed ends, and then nail through the rungs to them.

Safety in using ladders is compounded of one part experience and four parts common sense. Here are some commandments for safe ladder use:

1. Never use a ladder that isn't in good condition. Sometimes you may be tempted to use a rickety ladder for a short job—but it's scarcely wise to bet on a ladder when a broken rung can cost a broken leg.

2. Never climb a ladder without being sure that it is properly placed, that good footing is provided, and that no passerby, suddenly opened door, or anything else is likely to dislodge the base.

3. Never forget what kind of ladder you're on. This rule, although seemingly simple, can cause trouble when ignored. For example, the top section of an extension ladder generally has one rung missing to allow the latching mechanism free play; if, when you are using just the top part of such a ladder, you forget the missing rung on the way down, you may get a rude awakening. Again, a stepladder has little lateral stability and tips over sideways with relatively small provocation; if you forget this and reach out too far to one side, a bad fall can result.

The angle at which a ladder leans against a wall is of course crucial. In theory the more nearly it approaches the perpendicular, the less chance there is of slippage at the base; and the more it departs from the vertical, the less likelihood there is of a fall over backward. In practice, the following are safe angles of placement:

A 10′ ladder should have its base about 4′ 6" out from the wall against which it leans; a 20′ ladder should be about 6′ out; a 30′ ladder should be about 7′ 6" out; and the base of a 40′ ladder should be between 9′ and 10′ from the wall. These figures presume that the

This sturdy ladder was homemade of 2 by 4's for rails set with 1¼" by 3" rungs. Masons and carpenters often use such a ladder

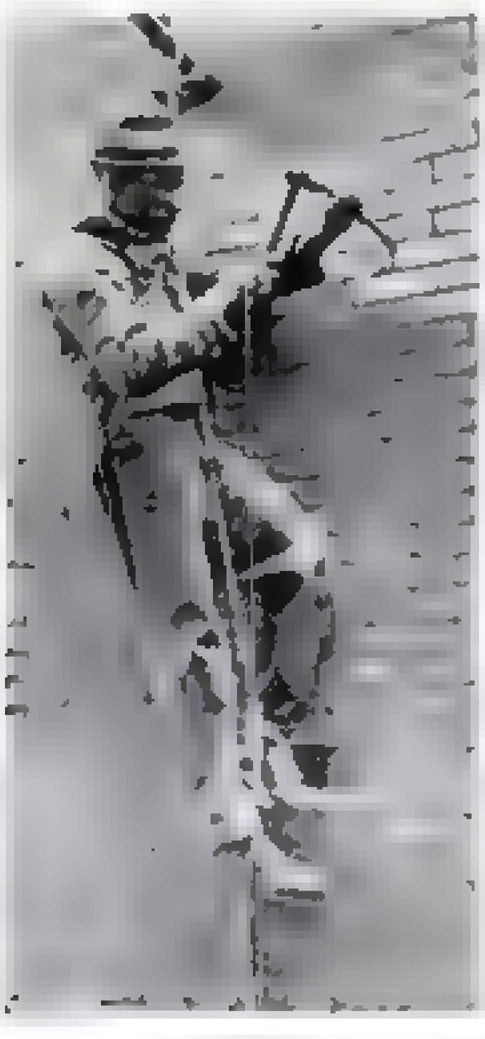
base rests on a level and fairly soft surface, such as dirt or grass. If the ground slopes away from the wall, or if the base rests on wood, concrete, or frozen ground, run a rope from the bottom rung to some firm point on the wall. In addition, be sure that each leg of the ladder bears on surfaces of approximately equal firmness. This precaution is particularly necessary with stepladders placed on the ground, as otherwise one of the loaded legs might suddenly sink into the dirt and tip the ladder over.

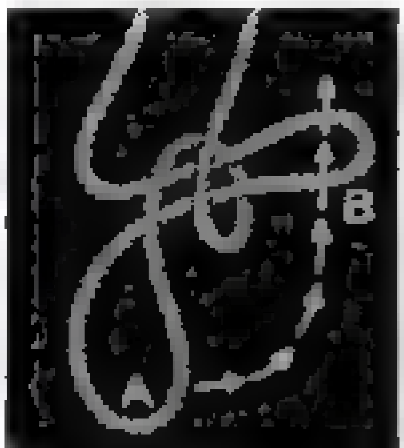
Wall brackets such as these keep an idle ladder out of the way. They permit the quick and easy placement or removal of a ladder

To lengthen the safe life of a ladder, apply a coat of paint at least once each year, letting plenty of paint soak into the joints where the rungs meet the rails. Do not allow a long ladder to remain extended for longer than necessary because its own weight will cause it to sag out of shape and may cause it to be permanently warped. If the ladder must be left outdoors on the ground, place it on boards to prevent warping and to keep the moisture out, and cover it with a tarpaulin to keep the sun from drying it out. Better storage is secured by building three hangers of the type shown in the accompanying drawing and spiking or bolting them inside or outside the garage. Still better preservation of a ladder can be achieved by keeping it indoors, lying on a flat surface and protected from both drying heat and excess moisture.

If you should decide to purchase a second-hand ladder, there are two simple tests by which you can check the condition of the wood. The first is to tap the wood lightly with a hammer, going over the entire ladder, including the rungs. Sound wood will give a clear, sharp answer to the hammer, whereas a rotten place can be located by a dull or hollow sound. The second test is to place one end of the ladder on the ground and the other on a sawhorse or box, and then stand on the middle of the ladder and spring up and down. Dangerous cracks may be either heard or seen; if you can locate only small weather cracks, the ladder is probably sound.

Loops in Rope Make Safe Working Sling

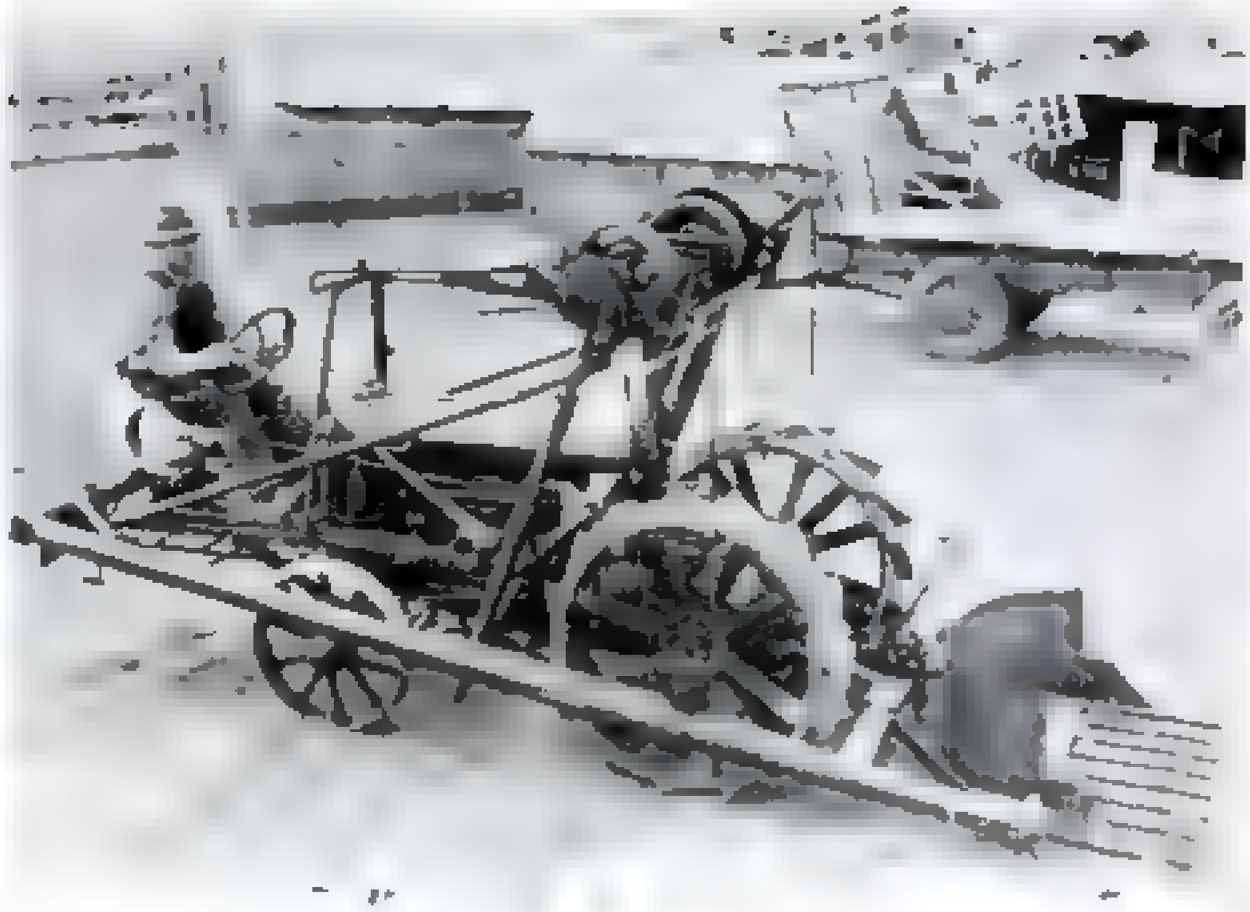




THREE loops tied in a stout rope form a convenient, safe working sling where a job must be done aloft at a spot where scaffolding or a ladder is unsuitable. Two loops are for the workman's feet, and the third is large enough for him to put his arms and body through. Spacing is determined by preliminary testing. A pad under the body loop is a help if the job is long.

Safe loops can be made by doubling the rope and tying a common overhand knot for each, but this type of knot tends to jam and become hard to untie. The knot shown at the left in two stages is much better. Simply double the rope to form a small loop, hold this in the left hand, and measure off the larger loop to the size desired. Let the larger loop hang and make two turns of the rope around the smaller loop; then pass the larger loop through the smaller one and draw the knot tight.—WILLIAM H. DAVIS.

Unique, with its steering mechanism reversed to put more of the weight on the operating end, the loader shown at the right must be driven backwards. The designer, Ralph T. Ashby, of East Garland, Utah, built it of parts from a John Deere spreader and used a header-pipe frame in making the arms. He incorporated the spreader differential in the lifting machinery, which gets its power from a belt drive on the tractor take-off. Although its weight is 1,000 lb., the loader can be turned in little space



Ingenious Loaders

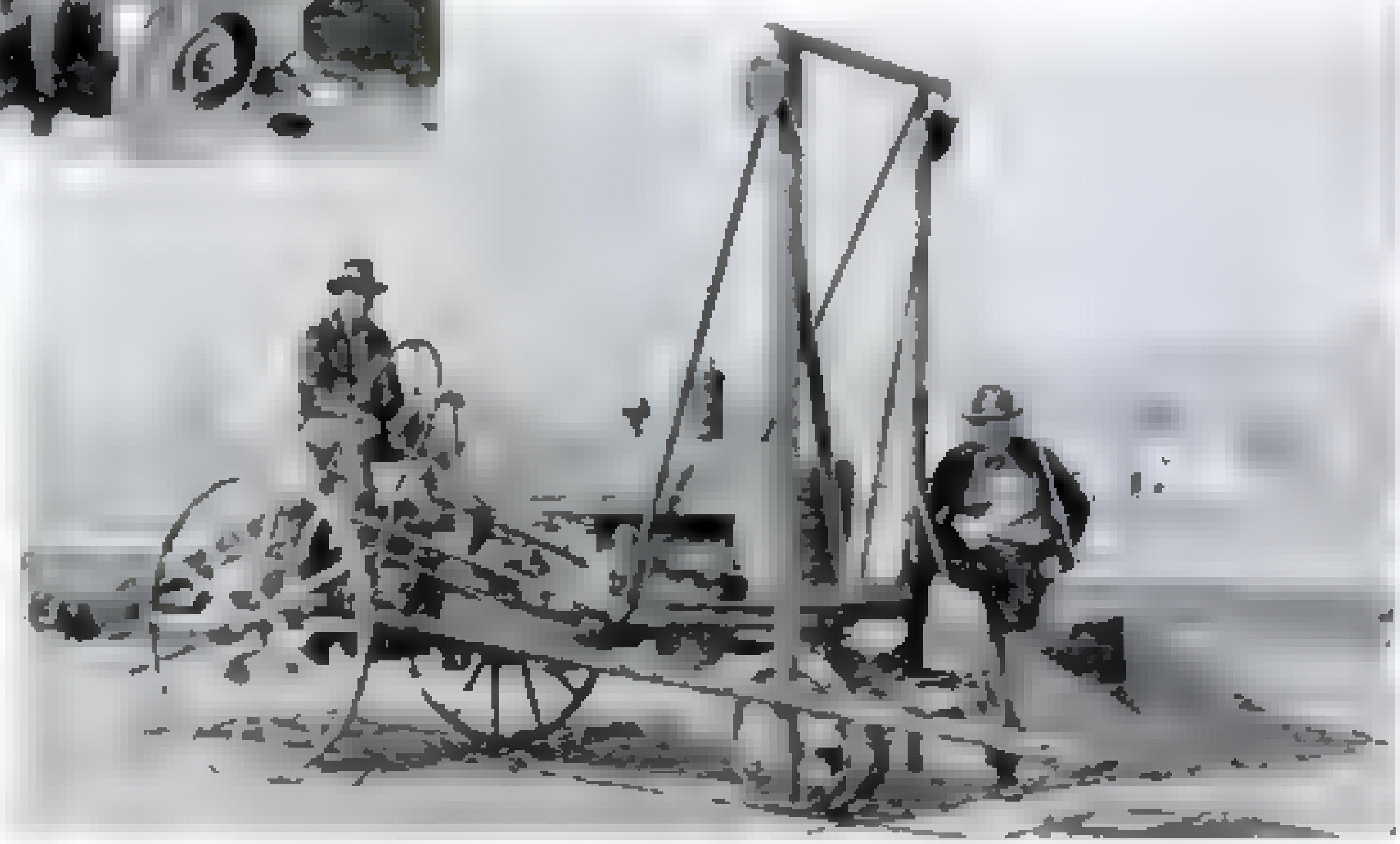
ENABLE WESTERN FARMERS TO LICK THE MANPOWER SHORTAGE

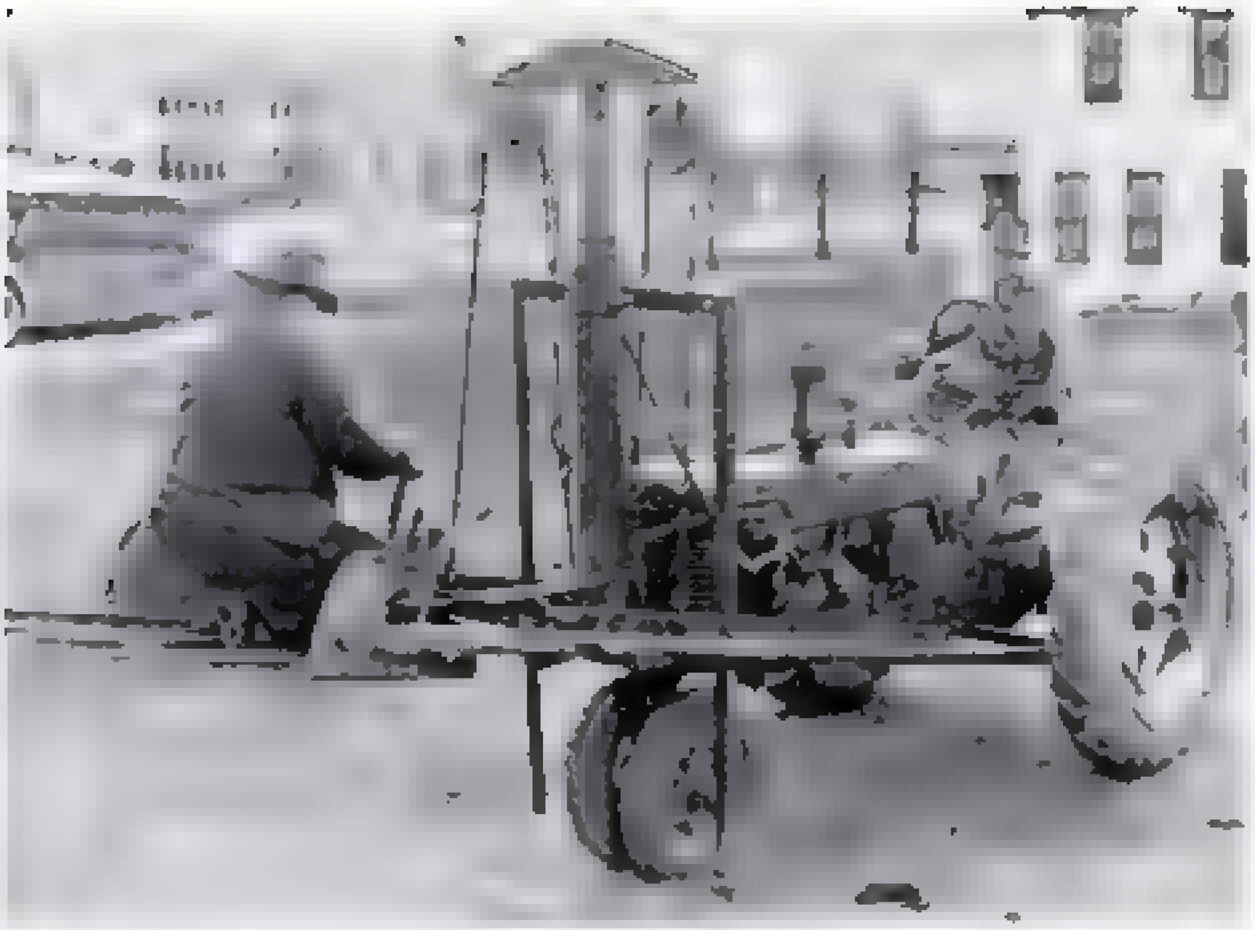
THE inventive genius of the American farmer has turned to solving his manpower problems. Growers in the Bear River Valley section of northern Utah are manufacturing their own supplementary farm machinery to do the work of men lost to the Army.

Loading of manure and various crops requires an important part of the manpower needed on a farm, but it is work that can be done by machinery—if you have the machinery.

The Bear River Valley farmers went

An old Dodge rear end and transmission turn spools that wind up wire cables to give lifting power to this loader, which was built by Joseph Oyler, of East Garland, Utah. The hand in the close-up view above points to a loosely set steel band around the old Dodge emergency-brake drum. The drum is free as the bucket rises, but the band grips it on lowering to hold the bucket at a good dumping height





Making use of a hydraulic lift salvaged from an old dump truck, this loader, designed by Martin Wood, of Tremonton, Utah, gets its lifting power from a pump geared to the motor at the left front of the tractor. The arrangement provides plenty of power, though the loader weighs only 400 lb. and is not as fast as other models. Almost perfect control is exercised by means of the long handle on the side, permitting the lifting of a 250-lb. man with ease. The loader is mounted on a standard Farmall tractor.

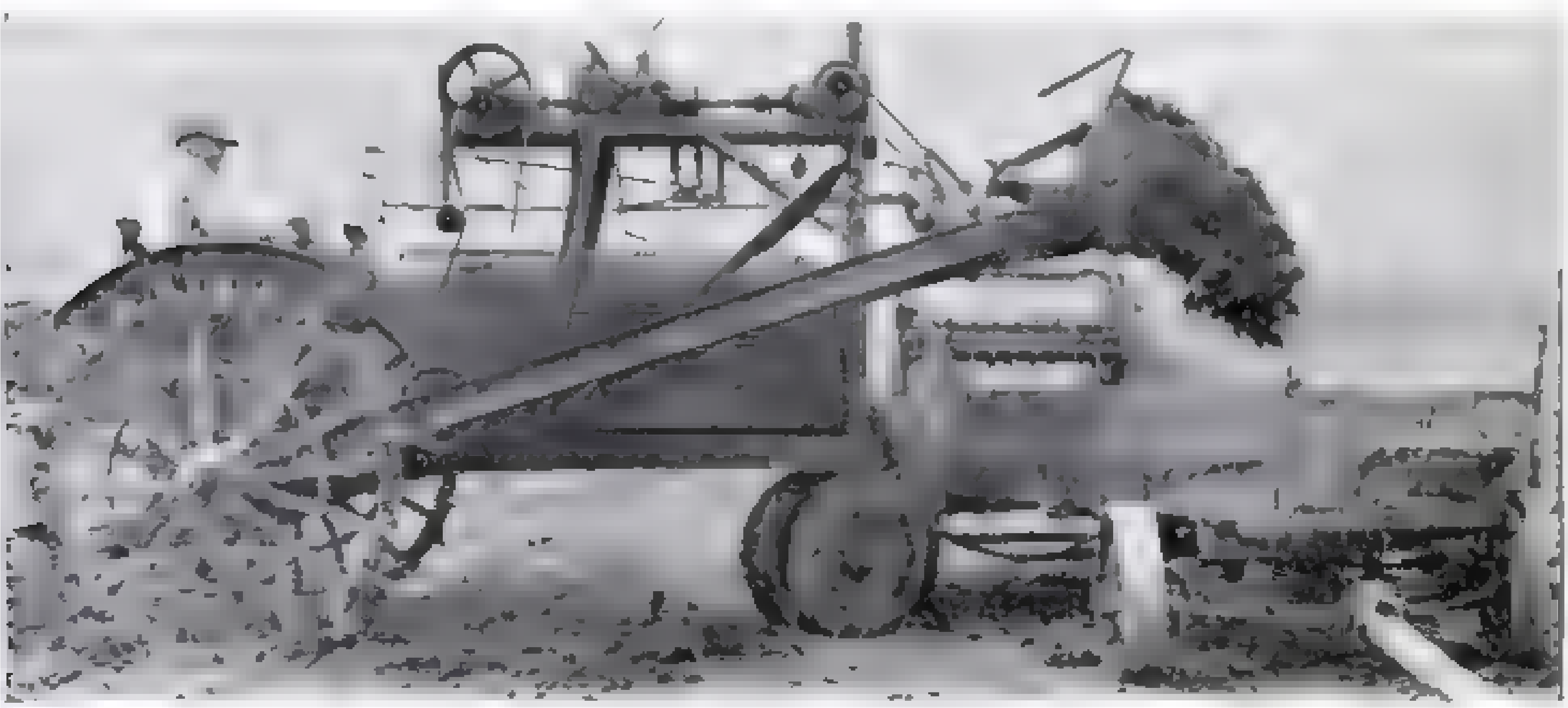
Built from Scrap

to H. M. Skinner, farm-mechanics instructor at the county high school, for help. Skinner made the problem a class project for his students, and they worked with the farmers to design and build six different types of successful loaders, using parts from old threshing machines, headers, harvesters, and other farm equipment, and even from old automobiles on farm scrap heaps.

All the loaders they designed are mounted on farm tractors, and lift power is supplied from the take-off shaft. Nearly all use the transmission and rear end of an old automobile for gearing and distributing this power.

One man and any of these loaders can keep five 70-bushel manure spreaders busy —a good 10-man job. In loading pea vines, each loader can again do the work of 10 men. Any of the machines can be easily adapted for loading gravel, ashes, sand, earth, or coal, and in winter they can be used for clearing roads of snow. Their weight varies from 400 to 1,000 lb., and the only cost is about 100 man-hours each if the parts are taken from the scrap pile.

Side power take-off, through a Model T Ford rear end and a Dodge transmission, differential, and clutch, is employed in the design of this loader, which was built by Sterling and Leland Burton, of Fielding, Utah, with the assistance of neighbors



FOUR COMMANDMENTS FOR

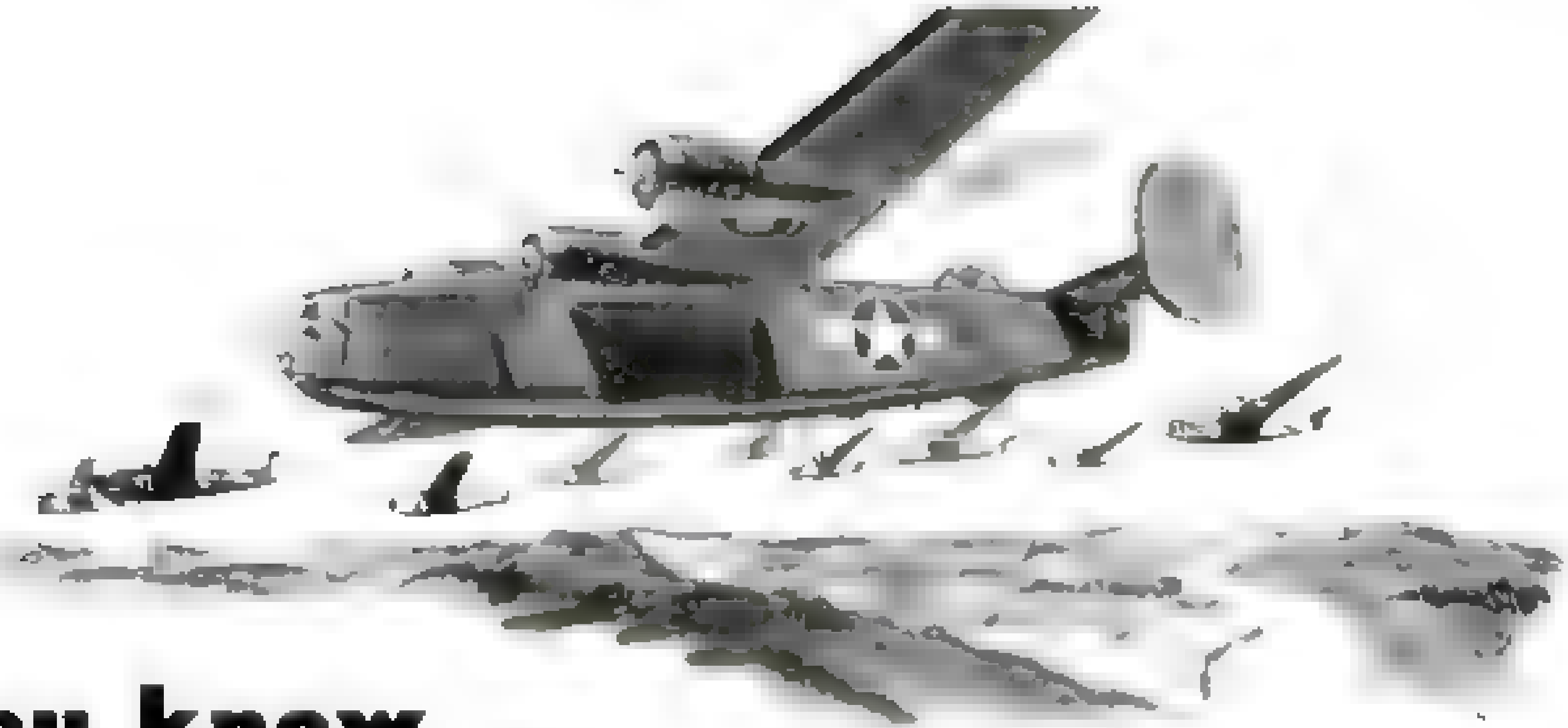
Saving Furnace Fuel

DON'T WASTE HEAT by not making full use of wall and attic insulation, storm sash, and weatherstripping. All exterior cracks should be calked. Chimney dampers should be closed except when fireplaces are in use.

DON'T HEAT NEEDLESSLY by neglecting to shut off the radiators and pull down the shades in unused rooms. Since sunrooms and garages are often hard to heat, it may be better to cut off the heat there as well. Set the thermostat at 50 deg. during week-end absences and while the house is aired.

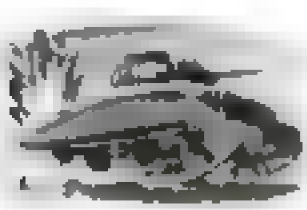
DON'T OVERHEAT the living quarters of your house by setting the thermostat above 69 or 70 deg. Physicians say that overheating is undesirable and that temperatures as low as 64 deg. are sufficient for healthy adults. The use of a fireplace may also afford a saving, provided that your fireplace fuel is not too costly and that you then allow the rest of the house to cool. Adjust radiator valves to give maximum warmth in the bathroom and living room, and less heat in the kitchen and bedrooms.

GET MAXIMUM EFFICIENCY. Be sure that your furnace is clean and in good condition, and that pipes and ducts, as well as the hot-water tank, are well insulated. With an automatic furnace, make certain that the firing, mixing, and draft-controlling devices are properly adjusted. Check up on the condition of the radiator air valves in a steam system or of the air vents in a hot-water heating system. If hot air is used, examine the ducts for cleanness and tightness, and provide a cold-air return if there isn't one. Be sure that the thermostat is correctly located, away from both drafts and direct radiant heat, and that its operating cycle is of the proper frequency for your heating system. Use nonmetallic paint on radiators, and install foil reflectors behind them in order to increase the amount of radiation.



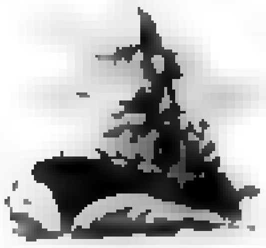
Do you know . . .

How many G-E lamps on a four-motor bomber? About 200. That means something over 200,000 G-E lamp bulbs to equip a 1000-bomber mission...all the way from tiny bomb indicator lamps to powerful airplane landing lamps.



How many G-E lamps on a M-4 tank? 27 . . . about the same number of lamps that you would find in the average small home.

How many G-E lamps on a fighter plane? Around 50, each with its special job, from signalling to sighting deadly guns.



How many G-E lamps on a battleship? About 30,000 . . . made not only to fit special needs, but to resist vibration and shock of pounding seas.

How many G-E fluorescent lamps in a well-lighted war plant? Over 2½ miles per 1000 workers . . . cool "daylight" for better seeing, better work.

How many G-E lamps to equip an armored division? 60,000 . . . almost as many as the homes of an average city of 25,000 people use in a year.

How many G-E lamps for a life jacket? Only one lamp. But that one can be the difference between life and death for men lost at sea.

To fill the many needs of the armed forces, General Electric is making several hundred different types and sizes of lamps, specially designed for military use . . . in addition to lamps for war production and other needs. Each one of these lamps benefits from the same research and manufacturing precision that makes your General Electric lamps at home so efficient, so dependable. They're all *made to stay brighter longer!*

G E MAZDA LAMPS

GENERAL ELECTRIC

Hear the General Electric radio programs: "The G-E All-Girl Orchestra," Sunday 10 p.m. EWT, NBC; "The World Today" news every weekday 6:45 p.m. EWT, CBS.

Why not buy an extra War Bond this month?

Precision Bombsight

(Continued from page 119)

tain its axis in a fixed direction in space. That is the principle of the gyroscope.

In precision bombing, it is not enough to have a man and machine capable of figuring a bomb's trajectory, and a stabilized sighting mechanism. Something has to be done to take the margin of human error out of the bombardier's release of his missile. In late-model American bombsights, there is an electric contact made with the bomb release, so that the dropping of the bomb may be done automatically at the exact instant when the angle is right. There is, of course, an alternate means of manual release, but it is not so accurate.

During a bomb run of 20 to 40 seconds, a human bombardier is under terrific strain. Probably he has had a long run to the target area. The night before his mission he has slept but little. Up in the transparent nose of the bomber he is the target for enemy fighter planes, diving into him with cannon and machine guns blazing, while flak from the ground batteries is bursting beneath him or clattering like hail on the plane he rides. So great is this strain that 25 missions have come to be the maximum for a bombardier in flights over German-occupied Europe.

Yet, strain or no strain, there come on every mission those few precious seconds in which he must set his bombsight for accurate fire on selected targets. If he delays a manual release of a bomb as much as one fifth of a second, the bomb will be wide of the mark. Hence the adoption of the automatic bomb release.

One further device has been worked out by America's aeronautical engineers still further to assure the accuracy of our bombing. It is a link between the bombsight itself and the automatic pilot. Human pilots are expected to bring our big bombers into the bombing runs in tight formation, so that maximum gun power may be brought to bear against intercepting fighters.

For a few fleeting instants, there is no need for the human pilot to concentrate on data from instruments for the most trying kind of instrument flying—holding the big ship at constant altitude and constant ground speed, as free from oscillations as is humanly possible.

Two mechanisms only are flying the ship—the bombsight itself and the automatic pilot. Instead of turn indications being given to a human pilot by needles on a panel, the airplane is held closely on the reading indicated by the bombsight's directional gyroscopes. Through these vital seconds no

(Continued on page 214)

Little BUT Mighty

IN WAR AS IN PEACE

A piston ring looks insignificant alongside a mighty gun. Yet both are necessary—to winning the war.

Consider that the simple, inexpensive installation of a set of piston rings can be counted on to restore performance and economy in a worn motor—for many more thousands of miles.

Consider that neglecting to repair an oil-pumping motor may result in a breakdown that will leave you without a car—indefinitely.

Obviously, the sensible thing to do is see your motor service man *before* trouble begins.

Should he find the installation of new piston rings advisable—and recommends Hastings Steel-Vents—you will know he does so out of experience.

HASTINGS MANUFACTURING COMPANY, HASTINGS, MICHIGAN
Hastings Mfg. of Canada, Ltd., Toronto

It's a privilege to buy War Bonds

HASTINGS

STEEL-VENT PISTON RINGS

Tough on Oil-Pumping
Gentle on Cylinder walls

Precision Bombsight

(Continued from page 212)

human hand is at the controls of the speeding plane.

The basic philosophy of precision bombing, as contrasted with the dumping of great masses of high explosive across broad areas, is very simple. It aims at a miracle in economical and merciful warfare that is almost as revolutionary as the American bombsight.

"To put an automobile out of commission," once remarked Gen. Edgar P. Sorenson, Assistant Chief of Staff for Air Intelligence in the U. S. Army Air Forces, "you don't have to destroy the whole automobile. All you have to do is to take out the rotating contact in the ignition distributor. Without it, the machine won't function."

Similarly, he said, to destroy the capacity of an enemy country to fight, you don't have to destroy the whole country, or even its armies. You knock out the heart of enemy production capacity, a chemical plant here, an airplane factory there, and a synthetic oil plant somewhere else. Gradually, and not at all spectacularly, you so disintegrate the enemy's internal economy that he is able to fight no more.

It is to make war cheaper in terms of casualties and mass destruction, he said, that precision bombing aims. Because of it, the task of our troops invading enemy territory is to be quicker of accomplishment, and accompanied by fewer losses. Because of it, we may be able to diminish the postwar hatreds which come to populations that have suffered too grievously. Because of it, we may have a smaller task of postwar rebuilding, and the nations now our enemies, with whom we some day shall have to trade, will more quickly get back onto a sound economic footing.

To the technical miracle of precision bombing, then, must be added an equal miracle, if the technique succeeds. The bomb, which started out as a monster of terror and destruction, is to become an instrument of mercy, like the surgeon's scalpel.

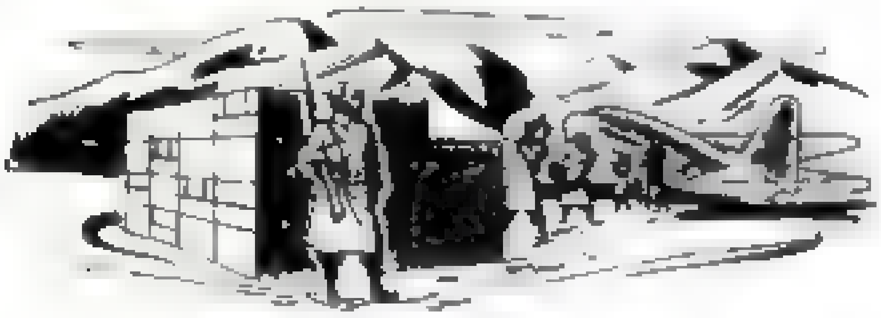
NOTICE TO SUBSCRIBERS IN THE ARMED FORCES

Subscribers in the armed services who notify us of change of address are requested to give us the key symbols appearing on the wrapper in which the magazine is received.

PROTECTING REPAIR

In motorized warfare, the maintenance and repair of motor vehicles is the responsibility of Army repair stations.

Delivering repair parts to these remote stations in usable condition has been a battle against such foes as the rigors of long sea voyages, rust, corrosion, rough handling, and attacks by the elements. For unless the ravages of salt water, dust, extremes of heat, cold and humidity could be prevented, vital replacement parts would quickly become so much useless scrap.



At the outset of war, Army officers experienced in the difficulties of truck servicing at remote places, and Chrysler Corporation Parts Division packaging engineers collaborated in solving this problem. With the added help of Chrysler Corporation Research Laboratories, a system of packaging was devised that assures arrival of repair parts in good condition.

Even though these precision-built parts may have to be unloaded in angry surf, hauled through jungle, stored in damp caves or stacked under the stars, their scientific packing assures complete protection from the elements, as well as making it easy to find the right part when needed.

WAR BONDS ARE YOUR
PERSONAL INVESTMENT IN VICTORY

CHRYSLER CORPORATION

PLYMOUTH · DODGE


PARTS — for Delivery Overseas!
Surface Protection, Wrapping and Sealing Becomes a Fine Art . . .
The first step is to apply a rust and corrosion preventive to all metal parts. Then a moisture-resistant, chemically-prepared covering is employed for wrapping each part. This wrapper gives two-way protection. Neither external moisture nor internal condensation and "sweating" can affect the part.
Transporting Ashore and Overland Requires Compact, Easily Handled Units
Each packing case is so designed that it saves up to one-third in cargo space. Handling is made easy by using only small-sized cases that can be ferried ashore in small native craft and carried to almost inaccessible land destinations.
Ingenious "5-Way Barrier" Adopted as Standard Overseas Packing Method . . .
A tailor-made carton is then provided for each type part. These cartons are placed in space-saving packing cases with moisture-proof liners. The overall five-way protection . . . rust proofing, wrapping, packaging, internal liners and the outside case—plus protection against mechanical damage—also acts as a shock absorber against rough and swift handling.
Fresh Air Repair Depots Function Smoothly . . .
Finding the right part quickly has been simplified by a code system for rapid identification of case contents. Weather-proof metal plates, attached at the factory, provide full descriptions. Each carton within carries its individual identification. Because of scientific protection, parts supplied to repair crews are in as fine condition as those used on Chrysler Corporation production lines.
War products of Chrysler Corporation range from little bullets to big tanks.
Tune in Major Bowes every Thursday, CBS, 9 P.M., E.W.T.
DE SOTO • CHRYSLER

Motorized Infantry

(Continued from page 66)

vehicles from hostile aircraft. This is no small problem, since there are some 3,000 cars and trucks to be hidden.

As a result, in a zone of poor concealment, the division's bivouac area may cover an area of six by eight miles, while in a heavily forested region it can be much smaller. In open plains or desert country, little or no concealment is possible, and about all that can be done is to disperse the vehicles widely to limit the damage possible from one bomb hit or shell burst.

Most carefully concealed of all, when the division is in bivouac, is the command post, the guiding brain of the entire organization. This post may be fairly elaborate in a relatively stable area; if the division is moving fast it probably will be in a single vehicle. In either case, it is the nerve center of the widespread net of communications—telephones, teletype, radio circuits, messengers, and signaling—which controls and co-ordinates the entire outfit.

Laymen sometimes ask why, if motorization confers such advantages, all infantry isn't on wheels. The answer is that while all modern divisions have vehicles for special purposes, the complete motorization of an entire army would be ruinously expensive and would create impossible problems of traffic and supply at the front. There is a point at which even the best vehicles will begin to get in each other's way. And, even the motorized division must normally depend on railway transportation from the rear bases.

Take the matter of fuel alone. The figures on gasoline consumption of American divisions are not published, but some idea can be gleaned from material recently released by British sources which have made a study of German fuel consumption. This took an average of all German vehicles—light, heavy, and armored—in the proportions in which they are used in combat operations. American organizations probably use about the same amounts; our gasoline is of better quality than much of the German synthetic product, but, on the other hand, our cars run to more horsepower than theirs and we use the jeep far more than the motorcycle.

The survey indicated that a German organization the size of our motorized division would require 100,000 gallons of gas to move 100 miles on the road. That is about 400 tons of gasoline, and it would take some 100 tank trucks to haul it. Truly, in 1943 an army marches on its fuel tank as well as on its stomach.

How Defoe Turns Things Upside Down

TO DOUBLE PRODUCTION OF WARSHIPS!

WITH record-breaking frequency, these days, flashing axes bite through stay-hawsers on the launching ways of the Defoe Shipbuilding Company at Bay City, Michigan . . . sending another and another destroyer escort ship for the Navy sliding down to blue water.

These are the famous DE fighting ships whose terrific execution among the U-boat wolf packs has helped bring the submarine menace under control.

Welded into one 750-ton piece of steel, more than 300 feet in length, the sturdy hard-hitting DE type ships are built upside down and then "rolled over" in their cradles to complete their equipment. This unique Defoe method of building ocean-going ships, eliminates the need of conventional ship scaffolding and by enabling workers to stand *over* the job from beginning to end gives remarkable advantages in saving time and labor costs. Among results obtained by Defoe engineering methods is the *doubling of production per man hour—with twice as many ships being built at half the labor cost per vessel!*

Until the Axis is defeated, the full facilities of the Defoe organization will be concentrated exclusively on all-out production for Victory.

But tomorrow, when Peace is restored, the experience and improved techniques learned in war work will be used to create new high standards of quality, value and economy in finer products for the consumers of America.

> *"Next to our immediate task of building warships faster and faster, the first responsibility of Defoe is to plan for post-war operation that will provide the maximum of gainful employment."*
>
> HARRY J. DEFOE
> Founder Defoe Shipbuilding Co.

★ ★ ★

BACK THE ATTACK—BUY WAR BONDS
Defoe workers take more than 10% of their pay in War Bonds

DEFOE SHIPBUILDING COMPANY, BAY CITY, MICHIGAN

Three White Star Renewal Citations now decorate the Navy "E" Award won by Defoe workers.

Defoe

Ships for Victory
Servants for Peace

Plywood with a Sting

(Continued from page 103)

and four 20-millimeter Hispano-type cannon in a hatch in the belly. The bomber version is totally unarmed, carrying four 500-pound projectiles in a standard belly bomb bay. Each modification is a varied mixture of this load.

While no one man can be called the father of the Mosquito, R. M. Clarkson, De Havilland's chief aerodynamicist, and R. R. E. Bishop, chief designer, seem to have been largely responsible for the ship.

When used as an intruder, the Mosquito's job is to sit in a revetment until the enemy bombers come over. Fast-climbing, heavily armed interceptor planes, such as special-version Hawker Typhoons, are the reception committee for the incoming bombers. By the law of averages, a certain number of the enemy planes will evade interception and get to their targets, or simply throw their bombs in a general area. Others, unable to pierce the defense, turn home, jettisoning their bombs to decrease weight. The intruders, informed of the bases from which the bombers have come, follow them home.

The Mosquitoes' superior speed guarantees that they will get to the Nazi landing strip before the returning bombers do. They make the trip close to the ground and sneak up as close to the illuminated landing strip as they dare—their flaps lowered, engines throttled, until they are barely hanging in the air. Only direct contact could reveal their position.

Upon arrival, the bombers turn on landing lights, and the regular interval of runway light is given each ship. Usually the bombers are low on gas and ammunition, and the crews are tired out. Then the Mosquitoes swarm in and litter the field with wrecks.

If the intruders' presence has been detected, the total absence of light warns the crew. Antiaircraft is silent, for fear of hitting the German ships. In this case, the intruders dive in, shoot up the runways and installations, and cause as much confusion as possible. Landing bombers must be diverted to other landing strips, and the losses resulting are almost as high as the Mosquitoes could inflict. The pilots, many of them green, must land in total darkness and radio silence in strange fields. Many of them run out of gas and have to take to parachutes, losing valuable equipment.

More difficult is the job of catching the enemy before he leaves the ground. Air Intelligence, through its complex system of photographic interpretation and confidential

(Continued on page 224)

IT'S THE LITTLE THINGS THAT COUNT — *like inspection for instance! Here a trained inspector is checking uppers with painstaking care. Shoes with flaws are rejected immediately. And every shoe must pass five such inspections before it can be stamped with the W. L. Douglas trade mark.*

The painstaking work of 260 hands goes into Douglas GOOD LOOKS!

Each W. L. Douglas Shoe is inspected five times during manufacture! Worked on by 130 pairs of skilled hands! Cut and stitched and finished by experts, who know every phase of the shoemaking trade, and take pride in perfect craftsmanship — that's the "reason why" behind the consistent good looks of every single pair of W. L. Douglas Shoes.

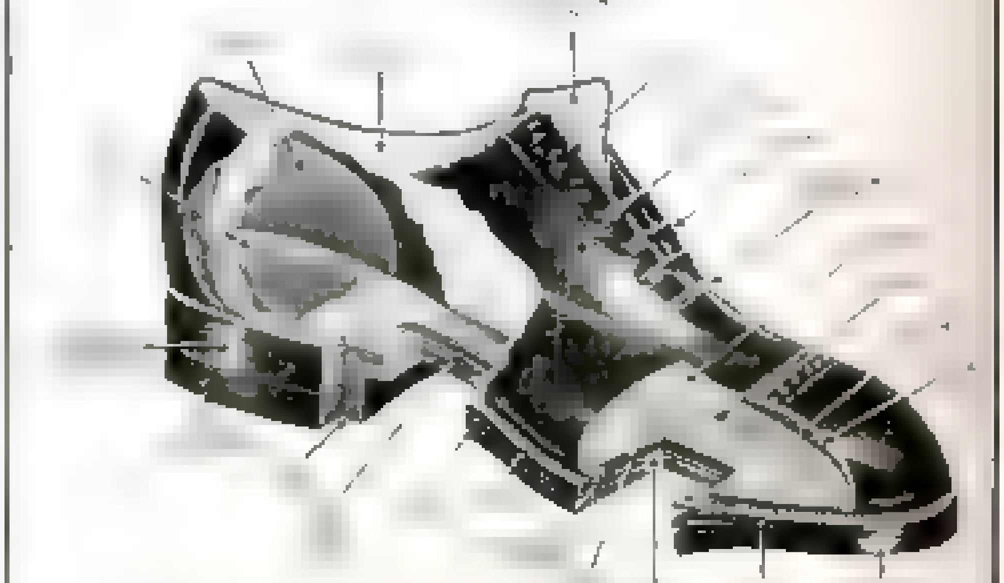
If *you* haven't yet got acquainted with the styled smartness of W. L. Douglas Shoes, see our new Fall styles today. Then decide for yourself where your shoe ration coupon will be best spent — Buy W. L. Douglas.

THE ETON
Rugged oxford in genuine scotch grain, antique finish, heavy leather sole. No. 46[illegible]5

$6.50 - $8.50

Some styles $5.50

Douglas "Down-to-the-Wood" construction assures you better fit



Construction of W. L. Douglas Shoes

W. L.
Douglas Shoes

W. L. DOUGLAS SHOE CO., BROCKTON 15, MASS.

Stores in Principal Cities—Good Dealers Everywhere

WAR BONDS AND STAMPS FOR VICTORY

Plywood with a Sting

(Continued from page 222)

reports, spots an enemy landing strip. Mosquitoes take periodic look-sees at the field. There is a hundred-to-one chance of finding a heavily laden bomber waddling down the field. The Mosquito pilot waits until the bomber is in a totally helpless position, gathering speed for the take-off. At the exact moment when the weight shifts from the wheels to the wings, the floodlights are turned on for a few seconds. Then the Mosquito dives in and gives the Nazi a long burst. Usually, the explosion can be heard for miles.

In daylight, the Mosquito is used for low-level attacks against communications. Its tankage gives it greater penetration into enemy territory than any other British fighter, while its two-man crew allows the pilot a freedom from operational and navigational worry that no single-seater could provide.

The DH-98's success as a bomber is due to the fact that at a certain altitude level it can outspeed any fighter the enemy can send in pursuit. The secret of this level is closely guarded, and some authorities believe it can be varied as the enemy varies equipment.

The Mosquitoes' bombs are usually of the delayed-action type, since the ships sweep in low. Once they unload their bombs, they climb (or dive) to their safety altitude, where they can outspeed attacking fighters.

The Mosquito's unusual freedom from ack-ack losses can be traced to an unusual technique. Instead of darting at top speed over the areas known to be ground-defended, it goes at cruising speed, the observer keeping his eyes peeled for gun flashes. When he spots one, he taps the pilot's shoulder. The pilot gives the engine "maximum goose," and the Mosquito accelerates over 100 m.p.h. in a matter of seconds. Thus, the ack-ack bursts about half a mile behind. Try as they may, Nazi gun crews haven't worked out a lead system to beat this.

Mosquito bomber operational commanders send out medley squadrons of bombers, fighter-bombers, and fighters, all looking alike—making life at a *Luftwaffe* interceptor base very uncertain.

This is the Mosquito. It made Quisling hide in a cellar, and kept the jittery *Herrenvolk* waiting hours for Goering's anniversary speech. It sneaked through the net that guards the heart of Germany's precision optical industry and blew up the tool-room in the famed Carl Zeiss works at Jena. By 1948 they will be able to replace the damage.


For Men Who Really Know Pipes
Royalton
CLUBMAN
TOWNSMAN
Royalton Silver Crown — Choice Grains — $5
A veteran pipe smoker may collect many pipes — but he is usually partial to a few favorites. Chances are they're Royaltons . . . A man comes to depend on his Royalton for keener satisfaction a case wherein long familiarity breeds affection. Gift suggestion: give him a Royalton. His gratitude will be rekindled each time he lights up.
WHEREVER BETTER PIPES ARE SOLD

Buy War Savings Bonds and Stamps regularly.


Once he was the center of the All-American line—now the colorful jersey, the cheering grandstands are far behind. Today he's dressed for harder, fiercer action. He's still the same character—only his appearance has changed. Plumb, too looks different in it's new "service" uniform.
But Plumb quality has not changed! You'll always recognize Plumb by its character and quality—by the graceful lines of each perfectly balanced tool and by the ease and speed with which it works. Master craftsmen have designed these tools to do your job quicker and better. Plumb quality remains the same—only the fine finish has gone for the duration, eliminated by government order.
Fayette R. Plumb, Inc.,
4837 James Street,
Philadelphia 37, Pa.
PLUMB TOOLS ILLUSTRATED Top to Bottom: Nail Hammer, Blacksmiths' Hand Hammer, Ball Pein Hammer, Half Hatchet
PLUMB
HAMMERS • HATCHETS • AXES • SLEDGES

Triumphs in Medicine

(Continued from page 84)

The discovery of the male hormone, which is credited to L. C. McGee, of Chicago, took place in 1927.

The sex hormones have proved enormously useful in the treatment of a variety of disturbances, including those of the sexual and reproductive functions. From this discovery was derived the original Aschheim-Zondek test for pregnancy.

The most important result of the discovery of sex hormones, however, is the light it has thrown upon the complicated structures and operations of the glands of internal secretion. These glands affect growth, development, metabolism, sexual function, reproduction; in fact, all phases of the "inner activities" of the human body.

The Relation of the Sex Hormones to Cancer

Cancer of the prostate is one of the most common types of malignancy affecting men. This type of cancer is difficult to discover in its early stages, and tends to spread so rapidly that, in actual experience, less than five percent of such cases can be successfully treated surgically.

In 1941, Dr. C. Huggins, of the University of Chicago, advanced the idea that the prostate cancer cells require the male hormone for their continued existence, even as the normal prostate cells do. He and his associates reasoned from this that castration or else the "neutralization" of the male hormone by means of the female hormone should adversely affect the prostate cancer growths. He, and others after him, tried the latter treatment. The results were astonishing. Although the cancer is not cured, most of the patients benefit enormously. Pain disappears, nutrition improves, appetite returns, and strength is regained. The original cancer growth in the prostate, and those that have spread to other parts of the body, regress so that many sufferers are enabled to carry on their normal activities in comfort. This treatment of prostatic cancer is vastly superior to any previously available. But the greatest value of the discovery is that it has stimulated many scientists to study the relation of the sex hormones to cancer in general.

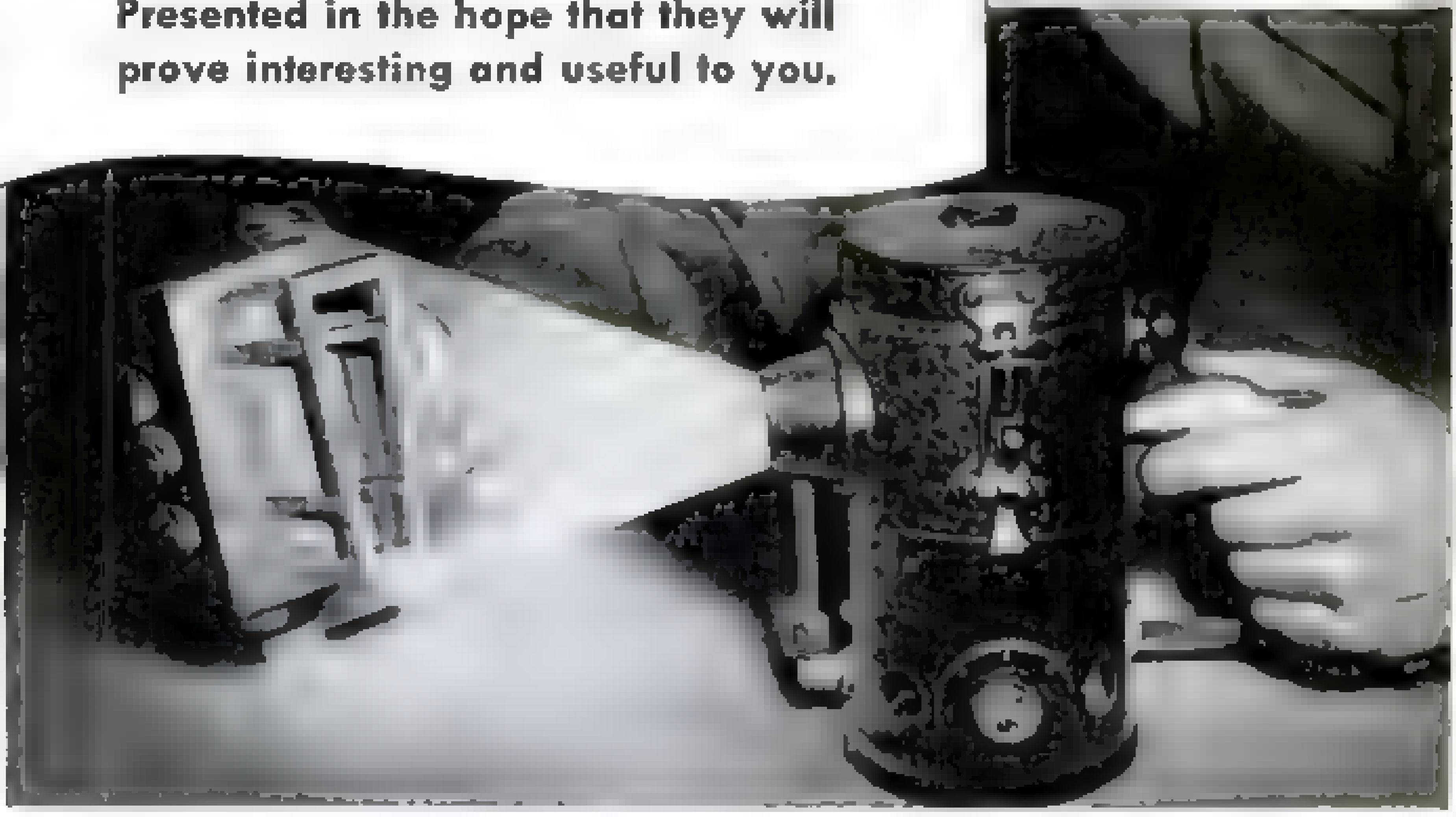
The Electro-Encephalograph

This recent invention is a sleuthing machine for tracking down the mysterious

(Continued on page 232)

Ingenious New
Technical Methods

Presented in the hope that they will prove interesting and useful to you.



Molten Metal Sprayed on Wood Patterns Prolongs Their Life

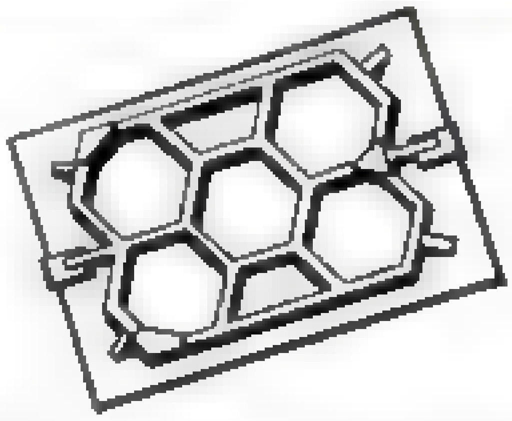
Molten metal sprayed on wood foundry patterns by a compressed air gun provides a protective coating against sand wear on the finished surfaces, thereby prolonging the life of the pattern and eliminating costly repairs.

The metal may be sprayed directly on the untreated wood surface of the pattern or core box. If the wood surfaces are hard or close-grained, a shellac primer is first applied, the metal being sprayed on before the shellac dries. The thickness of the metal coating is about 5 thousandths of an inch.

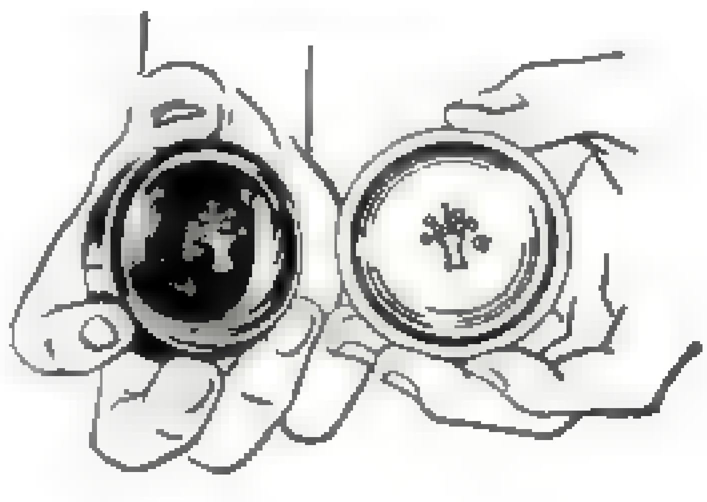
The spraying equipment consists of a portable, self-contained gun-type sprayer which melts the metal and is thermostatically controlled.

We hope this has proved interesting and useful to you, just as Wrigley's Spearmint Gum is proving useful to millions of people working everywhere for Victory.

You can get complete information about this method from Alloy-Sprayer Company, 2039 Book Building, Detroit, Michigan.



This wooden pattern coated with sprayed metal, has given service far beyond its normal life.



Fine detail easily recorded in the alloy sprayed onto pattern.

X-59


GREASE
HOW MEN HATE GREASE!
Old-fashioned, greasy brushless shave is out! Men are switching by the thousands to the new, improved Mennen Brushless Shave because it has this big advantage—it's a cream, not a grease! Get it today at your druggist's in either jar or tube.
MENNEN Brushless SHAVE
NO BRUSH
MENNEN Brushless SHAVE
A Novel Radio Program
"Ed Sullivan Entertains"
CBS Monday nights
7:15 pm EWT 9:15 pm MWT
6:15 pm CWT 8:15 pm PWT

Triumphs in Medicine

(Continued from page 228)

ways of the brain. Working by means of vacuum tubes similar to those used in a radio, it picks up "brain waves"—electrical impulses generated in the head by brain function. These currents, which have distinguishing characteristics, are visibly recorded by a moving pen. Since a brain suffering from some organic ailment sends out waves differing from those generated by a normal one, the record set down by the electro-encephalograph can be read by the brain surgeon for indications of such disorders as brain tumors and epilepsy. This useful diagnostic instrument promises to be of great value in the study of the physiology of the nervous system, and of the dynamics of drugs employed for their effects on the nervous system.

The Electron Microscope

The electron microscope likewise promises to prove a great research instrument. The ordinary microscope cannot magnify an object beyond approximately 2,000 diameters, this limitation being imposed by the wave length of light. The electron microscope, however, can magnify objects from 50,000 to a 100,000 diameters. It can, therefore, be readily seen how this extremely powerful instrument has opened up new and vast fields of research in bacteriology and biochemistry. We are now able to obtain a really intimate insight into the structure of both living and nonliving matter, and, most interestingly, of that "in-between" matter known as the viruses, which are responsible for such destructive diseases as smallpox, influenza, and infantile paralysis.

Psychosomatic Medicine

One of the more interesting developments of psychiatry goes by the name of psychosomatic medicine. It represents the fusion of orthodox clinical medicine with the best in psychiatric knowledge. It teaches the important lesson, in an irrefutable way, that there is no disorder of the soma (the body) without some involvement of the psyche (the mind and the emotions), and conversely, that psychiatric disorders have their somatic (physical) components. In some instances, indeed, physical symptoms are the only tangible manifestations of what is primarily a psychiatric condition. This insight into the interplay of psyche and soma has made possible a much more effective treat-

(Continued on page 234)


Get Ready Now
FOR HARD STARTING WEATHER!
CASITE
CASITE GUARANTEES
SUMMER STARTING IN WINTER WEATHER
OR
Right now — before real cold weather starts, ask about Casite's Winter Starting ability at your car dealer, service station, or garage.
Casite does two things which make any motor start better—and run better. First, it cleans out sticky, power-destroying sludge and gum from vital areas; second, it makes oil free-flowing, insures lubrication of high-friction parts.
Casite easy cold-weather starts save your battery, save your motor, save your disposition.
Remember... WE GUARANTEE
That any motor capable of being started in a warm room will start in the coldest weather when Casite is added to crankcase. Add Casite according to instructions. If your car fails to start, you get double your money back by filling out guarantee certificate and mailing to The Casite Corporation, Hastings, Michigan. Maximum refund is $1.30 per pint, which is twice nationally advertised price of Casite.
THE CASITE CORPORATION • HASTINGS, MICHIGAN
CASITE
MOTOR TUNE-UP
CASITE
CLEANS OUT MOTORS
KEEPS MOTORS CLEAN
It's a Privilege to Buy War Bonds

Triumphs in Medicine

(Continued from page 232)

ment of many conditions which in times past could be treated only superficially. It also enables the physician to anticipate, and by appropriate action to prevent, the development of a variety of physical and emotional strains and disorders.

Brief Therapy

Related to psychiatry is the new experimental development of brief therapy. The objective of these experiments is, simply, brevity of treatment. Most of the techniques of psychiatric therapy as practiced today are lengthy and therefore costly. Far too many persons who require treatment cannot afford it. And there are not enough trained psychiatrists available to meet the needs. To correct these deficiencies, studies, conferences, and experiments are being conducted to develop techniques of psychotherapy that will be effective but less time-consuming.

Biological Thinking

Finally we come to that development in present-day medicine which blankets all others: the ability to think biologically. Today the physician thinks of his patient in terms of his many environmental relationships—his job, his marriage, his friends, his education, his degree of success, and so forth. A short while ago, however, the physician thought of his patient only in terms of his complaints, of the symptoms or disorders he discovered and of the specific remedies he could use in the treatment of "the case." In fact, the physician was more concerned with the "case"—with the disease afflicting the patient—than with the patient himself.

Today, we know that to effect a permanent cure, the contributory as well as the primary factors must be considered and dealt with; that, in substance, the basis of well-being lies in achieving the best possible adjustment between the individual and his physical and emotional environment.

Familiar Faces

(See page 77)

Top row, left to right: John L. Lewis, Hitler, Churchill, Roosevelt, Mussolini.

Middle row: Roosevelt, Willkie, Chiang Kai-shek, Duke of Windsor, Hoover.

Bottom row: Hirohito, Stalin, Duchess of Windsor, Mrs. F. D. Roosevelt, Al Smith.

Millions of "Small Arms" Essential to Victory

The sporting arms industry of America . . . long skilled in the ways of gun-making . . . undertook a tremendous task in production of arms for our Government and its Allies.

The record of its achievement, in quality and stupendous quantity, is a vital factor in America's guarantee of victory.

"Savage" with its thousands of workers is proud to be a part of this industry's important war effort. Reports from all parts of the globe record the effective performance of the Browning Aircraft Machine Guns, and other guns and military rifles produced in our plants.

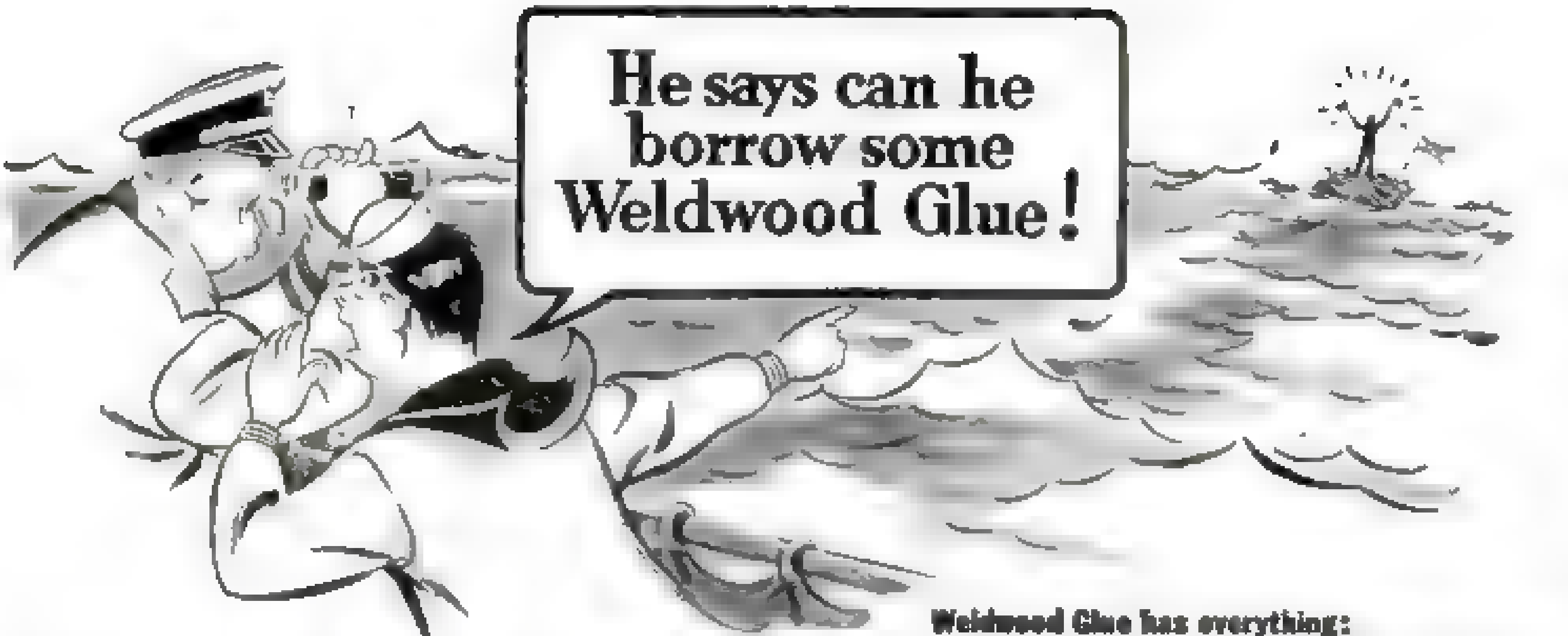
Savage Arms Corporation, Utica, N.Y.

Buy Wisely — Buy War Bonds

SAVAGE

Since award to Savage of the Army-Navy "E," new and higher production schedules have been exceeded.

SAVAGE AUTOMATIC SHOTGUNS will resume their steady rise in popularity which, before the war, culminated in the introduction of the lightweight model for upland hunting



You may never need to hold a life raft together with Weldwood Glue, but you ll find it's the handiest adhesive you ever used at your home work bench.

In fact, this easy-to-use plastic resin glue is a honey for hobbyists. Mixed just by adding tap water to the powder, it can be used immediately, is cold-setting (work can be handled in a few hours) and it makes a *permanent* bond!

Waterproof, rot-proof and bacteria-proof, Weldwood glue won't stain, or mar the most delicate color or finish.

Your hardware store or lumber dealer has handy packages of Weldwood Glue in 10¢, 25¢, 50¢ and 85¢ (1 lb.) sizes. Get a can today or send 25¢ and your dealer's name for a trial 3½ oz. sample. Supply limited, due to Uncle Sam's war needs.

UNITED STATES PLYWOOD CORPORATION
(*Weldwood Glue Dept. 15*) 103 Park Avenue, New York 17, N. Y.

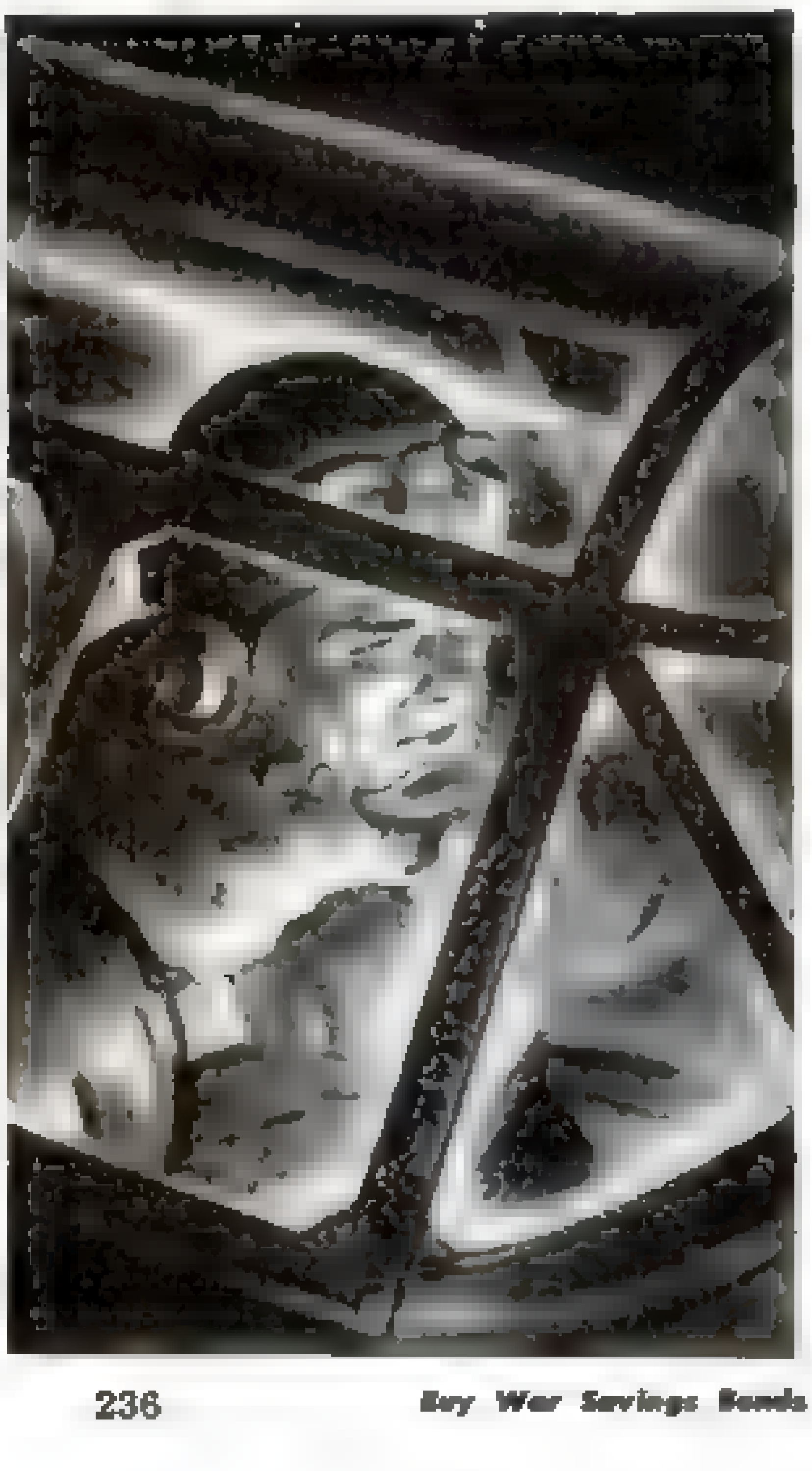
Weldwood Glue has everything:

1. Tremendous Strength.
2. Waterproof, Bacteria- and Rot-proof.
3. Quick and Easy to use. No heating. No waiting.
4. Economical.
5. Applied Cold, quick setting.
6. Stain-Free.

"Makes the glue line the SAFETY line"

WELDWOOD PLASTIC RESIN WATERPROOF GLUE

BACK THE ATTACK • WITH WAR BONDS



THERE IS NO SUBSTITUTE FOR EXPERIENCE

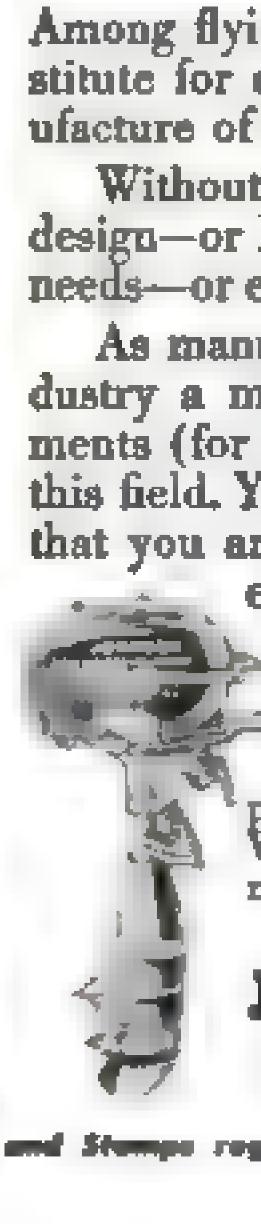
... in Airplanes or *Outboard Motors*

Among flying men the saying goes, "There is no substitute for experience." That's just as true in the manufacture of outboard motors as it is in flying.

Without experience one couldn't develop fine motor design—or be sure of materials best suited to outboard needs—or even achieve a *modern* outboard motor plant.

As manufacturers who have contributed to the industry a major share of accepted outboard improvements (for more than 20 years) we are *experienced* in this field. You may be sure, when you buy a Sea-Horse, that you are coming as close to perfection as experience has brought the outboard motor to date.

JOHNSON MOTORS, Waukegan, Illinois



All our present effort is being put into war work—24 hours a day. We think about peace-time outboard motors only in the "25th" hour.

JOHNSON SEA-HORSES FOR DEPENDABILITY


"HOME WOULDN'T BE HOME WITHOUT A HARLEY-DAVIDSON"
A LAD in our Armed Forces wrote us this letter:
"My job is motorcycle inspecting. Harley-Davidsons are sure doing a swell job in the Army. You wouldn't have to ask why, if I could take you with me on one of my test rides. There's where Harley-Davidsons show what they've got.
"I sold my Harley-Davidson when I entered the Armed Forces, but you can bet your bottom dollar that one of the next new Harley-Davidsons after the war will be mine, because home wouldn't be home without a Harley-Davidson."
That letter makes one of the best advertisements ever written about the dependable performance of Harley-Davidsons. All we can add is — "Put your fighting dollars in War Bonds and *own* a Harley-Davidson after Victory is won!"
Mail the coupon today.
HARLEY-DAVIDSON MOTORCYCLES
HARLEY-DAVIDSON MOTOR CO.
Dept. PS, Milwaukee 1, Wisconsin
Please send at once free copy of 24-page "Enthusiast" Magazine, filled with motorcycle action pictures and thrilling stories.
Name.....
Address.....
City..... (.....) State.....
SEND COUPON NOW
FREE!

 Buy War Savings Bonds and Stamps regularly.

Buy War Savings Bonds and Stamps regularly.

On many fronts . . . in many ways . . . large, capacious rubber boats serve our Navy and Marine Corps. Before launching they are compact "packages", easily handled, stowed, transported. Quickly the hulls can be unfolded . . . swiftly their compartments are inflated to plump buoyancy . . . motors are secured on special stern brackets . . . and they're set to go!

In a brief period a fleet of them can be readied for duty. With load capacity of several tons, they are used for rearming and refueling operations at advance bases. In landing operations, such a boat carries eighteen men, battle equipped, through heavy surf and over coral reefs. Highly maneuverable and amazingly light in draft, they can be operated in shoalest waters. They are driven by powerful, full-reversing Evinrude "Lightfour" motors specially developed for this service.

To meet the varied requirements of amphibious warfare on every front, Evinrude engineers have perfected numerous new developments and applications of outboard power, many of which have advanced the peacetime outboard motor into new fields of usefulness. Today these developments — and every motor we build — belong to America's armed forces. *After Victory* they will be yours . . . for your greater enjoyment of every hour on the water!

EVINRUDE MOTORS, ***Milwaukee 9, Wisconsin***

Evinrude Motors of Canada, Peterboro, Canada

EVINRUDE

OUTBOARD MOTORS

Dear Mayzo: I've seen a lot of the world since I last talked with you, but none of it looks as good as home . . . those pictures you sent look mighty good to me . . .

Make the most of your present camera! Take good care of it, and conserve vital film by making each picture a good picture. After Victory Argus will make new cameras . . . employing the new techniques and extensive experience acquired in War Production.

FINE AMERICAN CAMERAS
•
PRECISION OPTICAL INSTRUMENTS
•
AVIATION RADIO EQUIPMENT
•
BUY WAR BONDS

"Good Pictures"

Make the best use of your present equipment — learn more about lenses — films, filters and composition. Send 25c today for this 56-page booklet. Write Dept. S.

argus

INTERNATIONAL INDUSTRIES, INC.

ANN ARBOR • MICHIGAN

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of March 3, 1933, of Popular Science Monthly, published monthly at New York, N. Y., for October 1, 1943. State of New York, County of New York, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared Godfrey Hammond, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in Section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, assistant editor, and business manager are: Publisher, Popular Science Publishing Co., Inc., 353 Fourth Avenue, New York, N. Y.; Editor, Charles R. McLendon, 353 Fourth Avenue, New York, N. Y.; Assistant Editor, Arthur Wakeling; Business Manager, Godfrey Hammond, 353 Fourth Avenue, New York, N. Y. 2. That the owners are: Popular Science Publishing Company, Inc., 353 Fourth Ave., New York, N. Y.; Stockholders of Popular Science Publishing Company, Inc., Mansell and Company, 40 Wall St., New York, N. Y.; Alice A. Fisher, Greenwich, Conn.; Oliver B. Capen, Bedford Village, N. Y.; Noreen S. Capen, Bedford Village, N. Y.; Robert Cade Wilson, 683 Springfield Avenue, Summit, N. J.; Ada B. Wilson, 683 Springfield Avenue, Summit, N. J.; Marguerite N. Cole, Round Hill Road, Greenwich, Conn.; Raymond J. Brown, 217 Audley St., So. Orange, N. J.; Irma V. Hammond, 163 Brewster Road, Scarsdale, N. Y. 3. That the known bondholders, mortgagees and other security holders owning or holding 1 percent or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and [illegible] as they appear on the books of [illegible] stockholder or security holder [illegible] of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) Godfrey Hammond, Business Manager

Sworn to and subscribed before me this first day of October, 1943. Esther Eyl, Notary Public, Kings County. Kings Co. Clerk's No. 72, Registry No. 4083. New York County Clerk's No. 164, Registry No. 4 E 193. (Seal) My Commission expires March 30, 1944.

Please Mention Popular Science Monthly When Writing Advertisers

At your finger-tips!

DELTA Craftsheets

—technical 'know how' that adds to your skill, saves time, prevents errors in your

Home Workshop

Here it is — Batch No. 1 of Delta Craftsheets, 32 pages of clear, authoritative data from the world's No. 1 maker of home power tools. Increase your knowledge, turn out finer, more "professional" work, faster and with fewer waste motions . . . Reprinted on heavy paper from The Deltagram, the magazine for home craftsmen, in a handsome loose-leaf binder.

Valuable reference material

Clear and practical to the last detail, Delta Craftsheets give you quick, easy access to information that shows you how to produce work that marks you as an expert. They provide — in inexpensive form — tables, charts, and diagrams usually found only in high-priced books.

For example:

In Batch No. 1 you find a sheet showing how to compute pulley speeds, complete with examples and diagrams.

Another sheet shows how to cut mitred segments for figures having from 3 to 14 sides.

There are sheets on Shaper Knives, Spark Test for Metals, Taper Turning—Setover Method, Application of 3-Knife Cutter Head, Abrasive Disks (with table for selecting and instructions on fitting), Standard Wood Mouldings, the Lathe Indexing Head, Types of Hinges (2 sheets), Layout Problems, and many others.

Tables and Charts

Included in this Batch of Craftsheets are valuable tables and charts of hard-to-find information, such as: Speeds and Lubricants for High Speed Taps and Drills; Basic Thread Dimensions and Tap Drill Sizes; Common Wire Nails — size, length, gauge, etc.; Tables of Cutting Speeds; Counterbore Sizes for Cap Screws and Machine Screws, etc.

Add to your Library

These Craftsheets make an important addition to your home workshop library, one that grows even more valuable as additional batches are issued.

You may order the binder or the sheets separately. But for permanent neatness and convenience, we suggest that you order both.

Fill out the coupon and mail it today with check, money-order, or stamps. Send promptly to be sure of early delivery.

HM-5

Batch No. 1 of Delta Craftsheets 25¢
Handsome Ring Binder . . . . 50¢
Total . . . . 75¢

Tear out and mail coupon today

Editor, Deltacraft Publications
THE DELTA MANUFACTURING CO.
682N E. Vienna Ave., Milwaukee 1, Wis.

I am enclosing.......................for:

☐ Batch No. 1 of Delta Craftsheets only..........25¢
☐ Ring Binder for Delta Craftsheets..........50¢
☐ *Both* Batch No. 1 and Ring Binder..........75¢

Name..

Address..

City..........................(.....) State..........................